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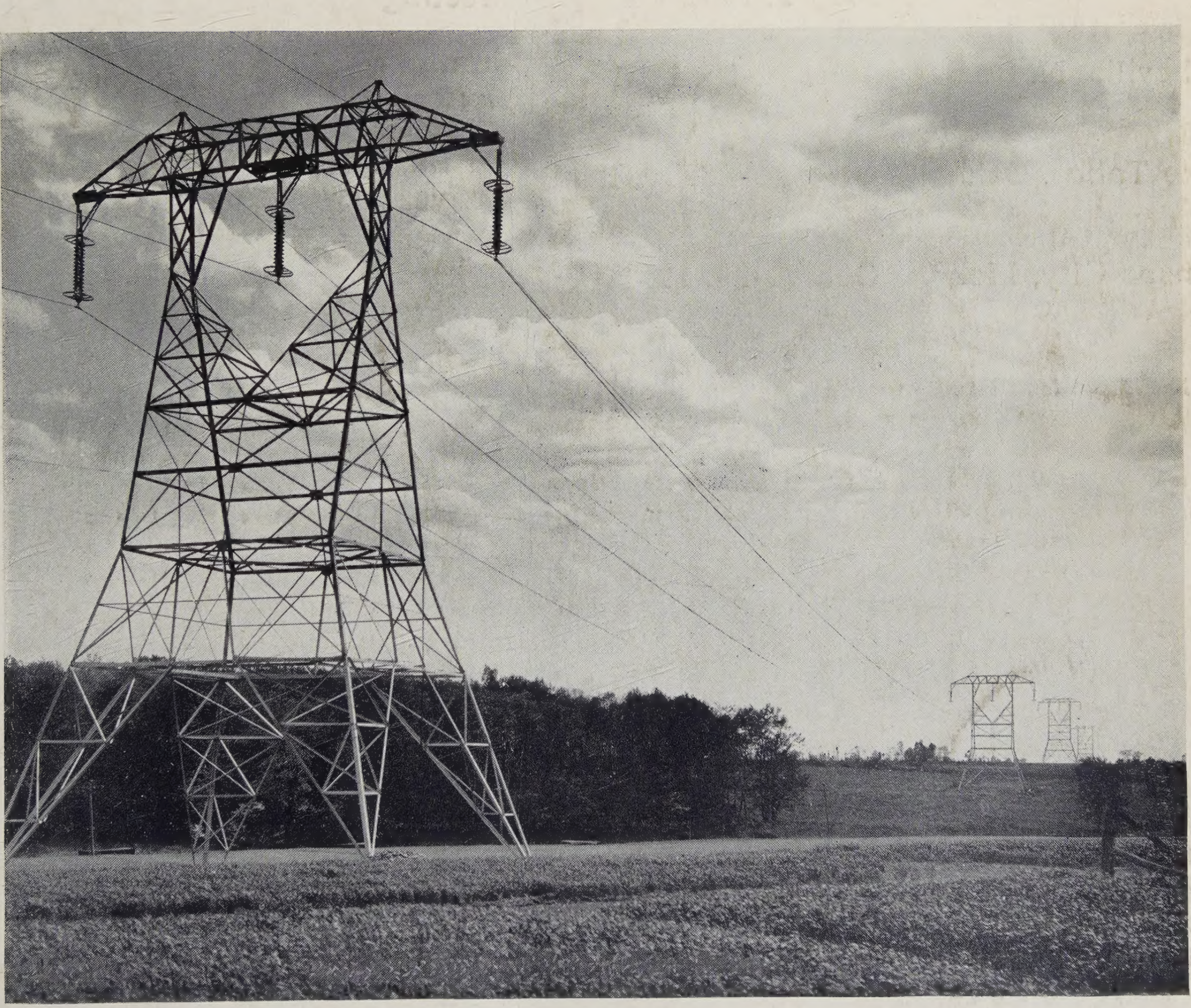

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FUTURE MEETINGS

of the

American Institute of Electrical Engineers

Place	*Dates*	*Nature*	*Latest Date for Receipt of Manuscripts*
Pittsburgh, Pa.	March 11-13, 1931	District Meeting	(Closed)
Rochester, N. Y.	April 29- May 2, 1931	District Meeting	(Closed)
Asheville, N. C.	June 22-26, 1931	Summer Convention	March 23, 1931
Lake Tahoe, Cal.	Aug. 25-28, 1931	Pacific Coast Convention	May 25, 1931
Kansas City, Mo.	Oct. 22-24, 1931	District Meeting	July 22, 1931

NOTE: Members who are contemplating submitting papers for presentation at any of the above meetings should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so that their papers may be docketed for consideration by the Meetings and Papers Committee, as programs for all meetings are formulated several months in advance. Upon receipt of this notification, Institute headquarters will mail to each prospective author information in regard to the Institute's rules relating to the preparation of manuscript and illustrations.

MEETINGS OF OTHER SOCIETIES

MIDWEST POWER ENGINEERING CONFERENCE, Chicago, Illinois, (G. E. Pfisterer, 308 W. Washington, Blvd., Chicago), February 10-13, 1931.

THE AMERICAN PHYSICAL SOCIETY, 169th Meeting, New York, N. Y., (W. L. Severinghaus, Columbia University), February 27-28, 1931.

AMERICAN INSTITUTE OF MINING ENGINEERS, Annual Meeting, Engineering Societies Building, New York, N. Y., (H. Foster Bain, Secy., 25 West 39th Street, New York), February 16-19, 1931.

NATIONAL ELECTRIC LIGHT ASSOCIATION, Engineering Section, Minneapolis, Minn., (J. W. Lapham, 803 Plymouth Building, Minneapolis), February 23-24, 1931.

NORTHWEST ELECTRIC LIGHT AND POWER ASSOCIATION, Engineering Section, Wenatchee, Wash., (B. Snow, 1208 Spalding Bldg., Portland, Ore.). March 18-20. 1931.

SOUTHEASTERN DIVISION, N. E. L. A., Vinoy Park Hotel, St. Petersburgh, Fla., (C. M. Kilian, 509 Haas-Howell Bldg., Atlanta, Ga.), April 1-3, 1931.

SOUTHWESTERN GEOGRAPHIC DIVISION, N. E. L. A., Mineral Wells, Tex., (S. J. Ballinger, San Antonio Public Service Co., San Antonio, Tex.), April 21-24, 1931.

AMERICAN ELECTROCHEMICAL SOCIETY, Hotel Tutwiler, Birmingham, Ala., (C. G. Fink, Columbia University, New York), April 23-25, 1931.

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Dr. Arthur E. Kennelly, professor emeritus of electrical engineering at Harvard University, past president A. I. E. E. (1896-1900), past president I. E. S. (1911), past president I. R. E. (1916), and well known both nationally and internationally for his versatility and untiring work for the betterment of the profession as applied to industry, comments further in this issue on the subject of internationally standardized magneti ccircuit units. (*See pages 133 and 141*)

◆

W. S. Lee, president of the Institute, genial Southern gentleman, and conqueror of tremendous engineering undertakings, throws down the gauntlet in characteristic fashion in his declaration of "The Engineer's Duty to Himself and to the Public." Mr. Lee's wealth of engineering experience and his first-hand knowledge of men and affairs gives him a foundation from which to speak; his honest fearlessness enables him in an unimpassioned way to issue his challenge to his brother engineers. (*See page 125*)

◆

D. C. Prince has made numerous discoveries and important contributions to the electrical engineering art. His studious application has carried him from a-c. motor developments to airplane machine gun design, and from radio engineering to mercury-arc rectifier research and design. His attention now is turned toward oil circuit breaker improvements. With the collaboration of W. F. Skeats he outlines important refinements in design which have led to the development of the oil-blast circuit breaker. (*See page 134*)

◆

R. M. Stanley has been devoting his time and engineering talent to electrical utility design, operation, and economic problems for some twenty-three years. He has been an aggressive leader in the promotion and adoption of engineering refinements in electric power equipment and has pioneered many of the paths now becoming familiar in the fields of remote control and automatic operation of major power producing and handling apparatus. One of his latest efforts is exemplified in the Ohio Falls hydroelectric generating station which he describes with the aid of E. D. Wood. (*See page 128*)

Winter Conventioners Viewed New York from its Newest Skyscraper, the 1,427-ft. Empire State Building (left).

ARAM BOYAJIAN for some time has been intimately associated with various phases of the stability problem as it involves electric power circuits and equipment. As a contributor to creative thought in this special field, Mr. Boyajian already has given considerable to active constructive debates at Institute gatherings. In this issue he discusses "The Physical Nature of Instability" in collaboration with O. P. McCarty. (*See page 110*)

◆

A. H. ONSTAD is a recognized Pacific Coast authority on electrification of lumber mills and incidental equipment. His accomplishments in this division of the field of electrical engineering well qualify him to speak upon the subject of "Electric Power in the Lumber Industry." (*See page 92*)

◆

PITTSBURGH, far-famed as America's steel city, asserts a just right to fame as an electrical engineering and electrical manufacturing center. The next district meeting on the Institute's calendar will be another Middle Eastern District meeting, to be held in Pittsburgh March 11-13, 1931. Many attractive features are offered. (*See page 138*)

◆

AN EXTENSIVE electrification program of the Reading Railroad in the Philadelphia area offered a definite opportunity for the joint use of a railroad right-of-way to accommodate both trains and electric power transmission lines. A combination of economic factors and engineering courage has established a noteworthy precedent. The installation is discussed by W. W. Wodruff and G. I. Wright. (*See page 102*)

◆

RECOMMENDATIONS covering seven specific items listed as having important bearing upon business' cyclic booms and recessions were made in a committee report presented to the American Engineering Council at its recent annual meeting in Washington, D. C. In addition to hearing the report the Council took a determined stand upon several important current and controversial legislative subjects of national interest. (*See page 148*)

◆

AS USUAL, the laboratory answers questions arising out of operating experience. In this issue there is given a comprehensive review of a symposium presenting facts and analyses pertaining to dangerous saturation phenomena which may occur in potential transformers, and to the causes of abnormal line voltages. C. T. Weller and C. W. LaPierre of the General Electric's general engineering laboratory present their findings as parts of a triad which includes a paper by A. Boyajian and O. P. McCarty. (*See pages 106, 110, 114*)

◆

A 1929 CENSUS of Manufactures, released by the U. S. Bureau of the Census, contains some facts and figures of current in spite of the fact that it is a year old upon release. (*See page 142*)

PROPELLER-type wheels with adjustable-blade features are opening up interesting possibilities in the direction of greater efficiency in low-head hydro plants. Experience and initiative both qualify G. A. Jessop and C. A. Powell to speak authoritatively upon this subject. (*See page 118*)

◆

"ENGINEERING LITERATURE" is the heading now used to embrace both the announcement of new books available at the Engineering Societies Library and the electrical engineering items selected each month from Engineering Index Service' listings of some 1,800 current technical periodicals. In connection with the typographical presentation of these latter items, a question has arisen concerning which a prompt statement of opinion from members using the service would be a great help. (*See page 157*)

◆

MERCURY-ARC rectifiers, gradually gaining a position of importance in the power supply field, have been applied successfully in the strenuous service of subway transit lines. Howard M. Van Gelder, electrical engineer of the City Transit Department, Philadelphia, presents an interesting discussion of the application of mercury-arc equipment on that city's new subway system. Mr. Van Gelder has been more or less intimately associated with electric railway work for more than thirty years, dating back to the initial elevated railway electrification in New York City. (*See page 97*)

Electric Power *in the* Lumber Industry

From logging to the manufacture of finished products the lumber industry depends upon electric power, frequently manufacturing its own from sawmill refuse. The changing order of affairs both inside and outside of the industry now emphasizes fuel economy, places an increasing premium upon wood-waste, and makes by-product electric energy an important revenue producer.

By A. H. Onstad

Weyerhaeuser Timber Company
Tacoma, Washington

ADVANTAGES accruing from the use of electric energy for the distribution of power and for electric drive around a lumber manufacturing plant are many indeed. Prior to the adoption of electric power transmission a lumber plant had at least two, (and sometimes more) complete power plants on its premises, each with a full complement of boilers, engines, pumps, and other equipment as well as a full operating force. One of these plants served the sawmill, one served the planing mill, and sometimes one served a box factory or other side line; or some power user that could not be reached by belt or rope drive from the main sawmill power plant.

Development of the low-pressure and mixed-pressure turbine generators stimulated the early adoption of electric power distribution. With a mixed-pressure machine installed in the sawmill power house to take exhaust steam from the sawmill engine (which usually was a Corliss engine) and to take all the steam from the many steam cylinders throughout the mill, enough power could be generated to serve the planing mill and other departments without drawing much live steam from the boilers. The cost of such electric generating equipment, plus the cost of the electric drives in the planing mill, frequently exceeded the cost of a separate power plant to serve the planing mill; but the investment was justified by the reduction in operating force and in maintenance cost.

Considered only from the angle of fuel economy, electric power as applied to the lumber industry, except in a few isolated instances, had no advantage over any other power until within the last decade. The lumber industry has had such a superabundance of natural fuel in the wood waste from its operation, that loggers have been careful to send to the mill only such logs as would produce a high percentage of merchantable lumber. Under normal conditions the sawdust produced from the lumber cutting and finishing machines is enough, and often more than enough, to serve local power needs. Any additional wood waste at the mill must be burned in refuse burners, which are expensive to build and maintain, and which usually scatter partly burned particles of wood over a wide area with attendant evils.

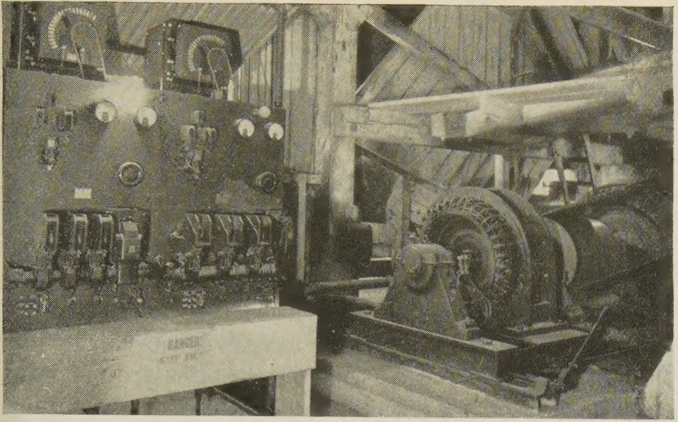
Gradually, however, because of various changing of incidental conditions, the economic situation with regard to fuel in the lumber industry is changing; wood waste is being used more and more in the production of various "composition boards." Changes made in the method of lumber milling are increasing steadily the kilowatt-hour consumption per unit of lumber, which is reaching as much as 121 kw-hr. per 1,000 board-ft. in some mills that are carrying the manufacturing to a fine degree. This change also is increasing demand for process steam.

These and other changes along with the possibility of selling surplus power to public utilities or other power consumers are placing an ever-mounting value on mill refuse; hence, instead of wood refuse being the traditional liability around mills, at many plants it now has an appreciative monetary value. With a contract for the sale of surplus power, a milling company can run its generating equipment practically at 100 per cent load factor; and if it has sufficient electric generating equipment it can turn all of its mill waste into revenue. Thus it has become imperative that efficient power plant equipment for the conversion of waste products into power be installed within the lumber industry. Motor applications also are being made with ever increasing emphasis upon power conservation in addition to the continuing demand for continuity of service.

One noteworthy example is the recently completed steam-electric generating plant of the Weyerhaeuser Timber Co. at Longview, Wash. In this plant the electric generating equipment consists of two 7,500-kw., 0.8-power factor, 2.3-kv., three-phase, 60-cycle turbine-generator units. Steam is delivered to these units at 300-lb. gage pressure at the throttle and 580-deg. fahr. With the units operating at full load, 150,000-lb. of steam per hr. at a pressure of 125-lb. gage may be bled from each machine for use in the lumber drying kilns.

Two 500-kw., 250-volt, d-c. generators driven by

Presented at A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930. (**No. 30-183.**)



Two-speed double-motor (synchronous) band-mill drive with associated automatic-control apparatus; 400-hp., 600-rev. per min. and 250-hp., 514-rev. per min.

synchronous motors supply current for 27 cranes used for handling lumber, as well as direct current for other d-c. motors and for the exciting current for the synchronous motors.

Some 1,200 motors, not including motor-driven tools such as portable drills and grinders, motor-driven electrical welding sets, electric clocks, and motor-driven office appliances, aggregate 23,849 hp. These include:

71	2,200-volt synchronous motors	10,645 hp.
30	2,300-volt induction motors	2,875 hp.
1,021	550-volt induction motors	8,575 hp.
78	220-volt direct-current motors	1,754 hp.

The load on this power plant with its 23,849 connected hp. averages 7,000 kw. and by the use of synchronous motors the power factor of the load is kept at 0.96 leading.

In the woods, electric power is now being used in a limited way for driving portable saws for falling trees and bucking them into long lengths. These saws are chains with cutter teeth attached to one side of the links which run over two sprockets, one mounted at each end of the light steel frame holding the sprockets in position and forming a guide for the saw chain. A specially designed motor of about 5-hp. capacity geared to the driver sprocket furnishes the power, taking its energy from nearby transmission lines, or from small gas-driven generator sets which may supply power to several such saws working within a limited area.

Electric power also is being used in a limited way for "yarding and loading" logs. This is the operation of dragging the log from where it was cut out of the tree and loading it aboard the cars for shipment to the mill.

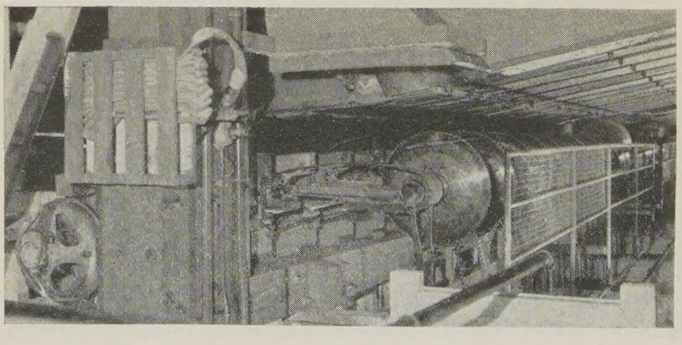
Equipment in use varies for various sections or growth of timber; on the Pacific slope of the Cascade Mountains where it is used to the greater extent, the equipment resembles heavy-duty hoisting equipment both in mechanical construction and in load characteristics.

The yarder is that part of the equipment that is used for dragging the log from the point where it has been cut out of the tree to the railroad siding for loading onto cars. Two full-load line speeds are provided, a high speed being 1,800 ft. per min. and the low speed being 900 ft. per min. The higher speed is used on the smaller logs and the lower speed for the heavier logs. This variation of speed is obtained through reduction gears of different ratios connected to the drum by friction clutches. The usual equipment is a 300-hp. wound-rotor motor having a wide range of speed control through secondary resistance. These motors are designed for a pull-out torque of approximately 300 per cent, but their service is such that frequently they are loaded to the stalling point.

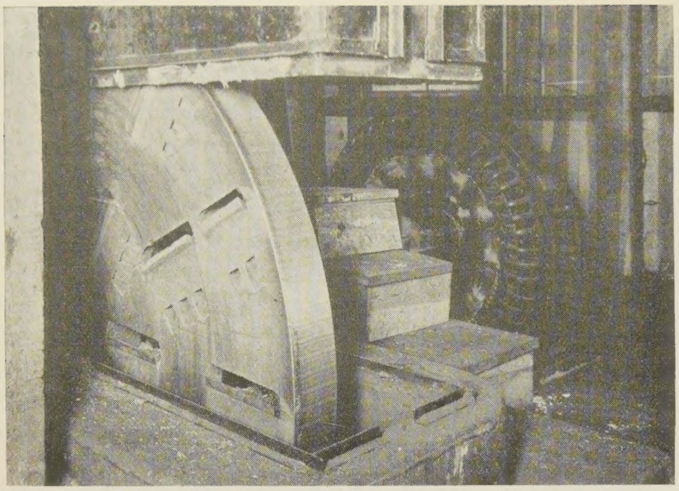
The loading end of this logging equipment usually consists of two 75- or 100-hp. wound-rotor motors. The hoisting line of the loading equipment passes through sheaves properly supported over the load. The usual procedure in loading a log is to fasten one hoisting line to each end of a log; the log can then be manipulated through these double hoists so that one end may be lowered onto the car ahead of the other to conform to the requirements of binding the logs into the load in such a way that they will arrive safely at their destination at the mill pond.

For a large operation on which load factor or days of operation per year is high, and in which life of operation is sufficiently long to permit of reasonable obsolescence charges, this has proved profitable.

One serious disadvantage to the use of electrical equipment for woods operation is the danger of loss of equipment by fire. The cost of electrical logging equipment is so great that the units are built only on order. The time required to replace a machine or repair one damaged by fire is therefore so great that it results in too severe a loss of production to warrant the adoption of electric power for logging operations except in a few special cases. Electric power for the propulsion of trains hauling logs out of the woods is being used in one or two instances, but insufficient tonnage on the average logging railroad prevents its general adoption even for this purpose.



A 250-hp. slip-ring motor driving a gang of trimmer saws



A typical 90-in. "hog" driven by a 400-hp. 600-rev. per min. synchronous motor. This machine reduces slabs and edgings to a refuse suitable for use in the furnaces

There is no specific rule governing the application of motor drive to sawmill machinery; power required for driving the various sections can be computed using the same laws that govern the application of electric drive to any other line of machinery. Before attempting to compute the motor requirements for these applications, however, one making these computations should be thoroughly familiar with the possible loading of the various sections to be driven. In applying motor drive to live rolls and transfer chains, the matter of obtaining sufficient starting torque is usually of prime consideration. The length of the roll trains and transfer tables is so short that if they are left in operation for a period of a minute or two they will completely unload all material that is on them.

Full-voltage across-the-line starters are used for all except wound-rotor and d-c. motors.

Selecting the proper starting equipment requires considerable thought, for with the frequent starting and stopping of the various sections, the duty imposed on the starting equipment is even more severe than that imposed on the motors. Maintenance men spend more time keeping the starting equipment in good operating condition than they do on the motors themselves.

There are many applications where thermal overload relays will not function if the doors of the cabinets enclosing the starting panels are left closed; this is due to the rise in temperature within the cabinets caused by the arc created in opening the motor circuit. Some of the transfer tables in the mill are started on an average of four or five times per minute.

One of the advantages of motor drive is the ease with which the machinery can be started and stopped, which permits running the machinery only through the period that it is actually engaged in moving lumber. As this in many cases is only a small fraction of the total working time of the shifts, considerable wear and tear of the machinery is prevented by stopping its movement when not actually needed.

Among recent applications of starting equipment that has proved worth while is the automatic starting and stopping trains of live rolls and transfer chains to permit the movement of lumber over them; for instance, a train of several sections of live rolls may be used for carrying timbers to the timber dock. As these timbers do not come with any degree of regularity, the rolls need operate only a small portion of the time, with a trip-pan arrangement placed between successive rolls throughout the length of the route. These trip-pans are mechanically connected to the starting stations of the motors driving the sections in such a manner that when the pan is depressed by the timber going over it, the motor is started and kept in operation until all of the pans in that train of rolls are free to rise to the "up" position. With such an arrangement each section of rolls is started as the timber approaches and automatically stops when the timber passes.

Adapting individual motor drive to the machinery of a lumber plant presents many perplexing problems; with few exceptions, the speed of the final drive of sawmill and wood-working machinery can be placed in two groups—a slow-speed group and a high-speed group.

Log hauls, transfer tables, and conveyors belong to the slow-speed group, with final speeds ranging from 1½ to 25 rev. per min. Live-roll drives ranging from 100 to 175 rev. per min. also can be placed in this class.

It was not until the so-called herringbone-type gear was developed and it became practical to build speed-reducing power transmissions of large reduction ratios that individual motor drive for these slow-speed groups became practical and economical. Now, reduction ratios of 150:1 with high efficiency may be obtained. This permits the use of motors of 1,200 to 1,800 rev. per min. to be used for practically every slow-speed drive, resulting in better electrical load characteristics and greater economy of installation.

Cutting speed for saws and the knife-type cutters of wood-working machines range from 8,000 to 14,000 ft. per min., which calls for speeds ranging from 300 to 7,200 rev. per min. These can be classed as high-speed drives. Mechanical connection between these and motors of economical speed characteristics did not present the difficult problems involved in the slow-speed drives.

Recent developments in planing mill machinery such as matchers, moulders, and saws, have opened a new field for the use of high-speed direct-connected motors. A large modern matcher has eight motors, totaling 270 hp., built into the machine. For these applications the machine manufacturers buy the rotor without a shaft and the stator without a frame and incorporate them in the construction of the machines. A modern matcher (commonly called a planer) has the following motors:

Service	No. Motors	Horsepower	Speed (r. p. m.)
Top cylinder	Two	40	3,600
Bottom cylinder	One	40	3,600
Outside side head	One	30	3,600
Inside side head	One	25	3,600
Top profiler	One	30	3,600
Bottom profiler	One	25	3,600
Feed work	One	40	1,200

As the cutter-head cylinders all turn in ball-bearings and are carefully balanced and heavy, they will continue to run for ten or fifteen minutes after the current has been cut off the motors. To make it possible to stop these quickly, the control is equipped for plugging service so that when it is necessary to stop a head or cylinder for any purpose the motor is plugged, bringing it to a stop in a few seconds.

Modern moulders are built for variable speeds of the spindle obtained by varying the frequency of the circuit by the use of frequency changers. For normal work the cylinders are equipped with six or eight knife cutters and usually operate at 3,450 rev. per min. For the exposed surfaces of the moulding requiring a finer finish the particular heads used for this exposed surface are speeded up (by changing the frequency) to 6,000 or 7,200 rev. per min. Control equipment is so arranged that the speed of any one or all of the five cutter heads or cylinders of the moulder may be increased.

Synchronous motors range in size from 50 hp. to 400 hp. and in speed from 225 to 1,800 rev. per min. Two types of loads are selected for synchronous-motor drive; (1) widely fluctuating loads having a low load factor, such as bandmills, edgers, slasher, trimmers and hogs; and (2) large loads of high load factors such as fans, pumps, and air compressors. Synchronous motors are not used on drives that require frequent starting.

All synchronous motors are wound for 0.8 factor and have a pull-in torque of 100 per cent of full-load torque. All synchronous motors are started with automatic, full-voltage, across-the-line starters and with few exceptions are all excited from the 250-volt buses or feeders that supply power to the cranes and other d-c. motors throughout the plant. Synchronous motors located so far from the d-c. lines that the cost of a d-c. circuit to the motor for excitation would be nearly as much as an exciter are equipped with direct-connected exciters.

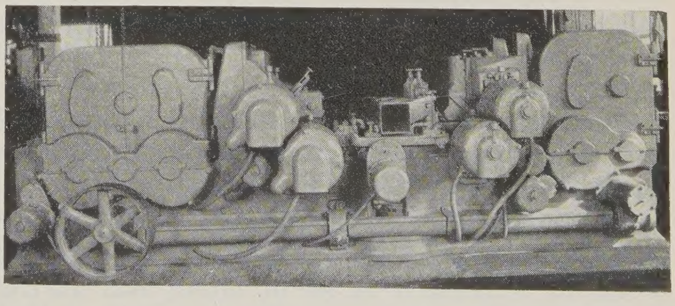
Synchronous motors have proved very satisfactory for widely fluctuating loads, the application to driving "hogs" being a striking example. Motors of 250 hp. at 600 and 720 rev. per min. and 400 hp. at 600 rev. per min. are used for this, and have field control relays so adjusted that when the motor pulls out of step because of overload, the field excitation is cut out, and automatically restored when the motor again approaches synchronous speed. This may occur as many as 100 times during an eight-hour shift.

The 2,300-volt induction motors range in size from 50 to 250 hp. These are mostly wound-rotor motors driving machinery requiring frequent starting, or machinery which will not permit the severe strains imposed on it by full-voltage across-the-line starting. Some equipment requires limited speed control and for this purpose the wound-rotor motor and drum controller are both used. Induction motors of 50 hp. and smaller ratings are wound for 550 volts.

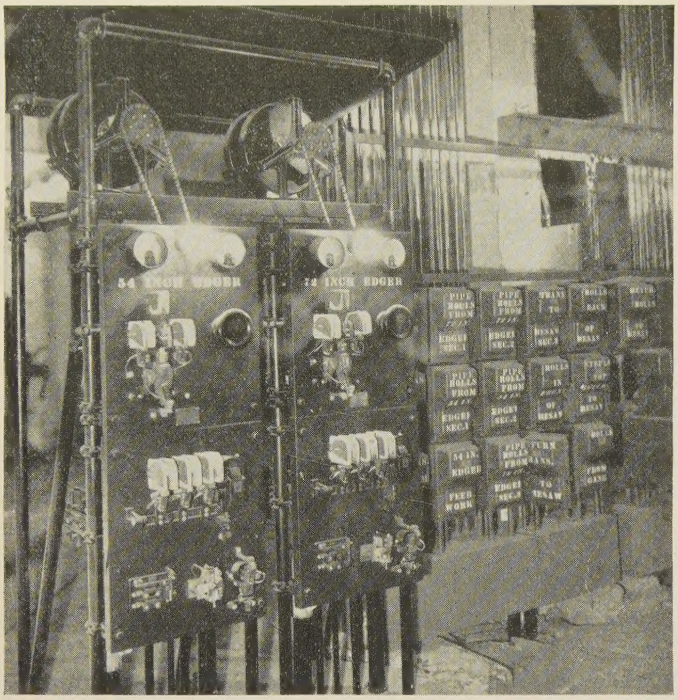
Except in sizes of 7½ hp. and smaller, the 550-volt induction motors are of the so-called double-wound-rotor type. These have the starting characteristics of the high-resistance-rotor motor and the running characteristics of the squirrel-cage motors.

One unusual motor application is that employed for driving the main bandsaw. For the regular run of fir logs a saw speed of 10,500 ft. per min. is the ideal speed; but for a certain species of fir log a saw speed of 8,000 ft. per min. is the most practical. As the logs requiring slow-speed sawing are mixed promiscuously with the softer logs, the custom has been to saw them all with the higher-speed saw. This has resulted in erratic sawing of the hard logs. At the Longview mill practically instantaneous speed changes from 10,500 to 8,400 ft. per min. are arranged for. This was accomplished by putting two synchronous motors on one motor base, driving the same pulley with the shafts rigidly coupled together. A 400-hp. 600-rev. per min. motor was installed as the main motor to use in starting the bandmill and for sawing the average run of logs. The other motor was a 250-hp. 450-rev. per min. motor. While the large motor is used for furnishing the power the small motor is disconnected from the line so that the only power required to drive it is that necessary to overcome windage losses. When a hard log is sawn the sawyer, by pressing two push-buttons, disconnects the large motor from the line and connects the small motor, which drops the speed of the saw to 8,400 ft. per min. The change from one speed to the other is made as frequently as the sawyer deems necessary.

Another unusual application of electrical power to sawmill machinery is in driving the feed works of the larger edgers, the machines that rip the boards and timbers into the desired widths. The edger arbor on which the saws are mounted is direct-connected to a 400-hp., 0.8-power factor, 1,200-rev. per min. synchronous motor. The feed rolls that feed the stock into



A modern high-speed planter; 9 of its 13 motors, varying from 2 to 75 hp., are shown



Typical arrangement of starting panels: automatic across-the-line synchronous-motor starters in the foreground

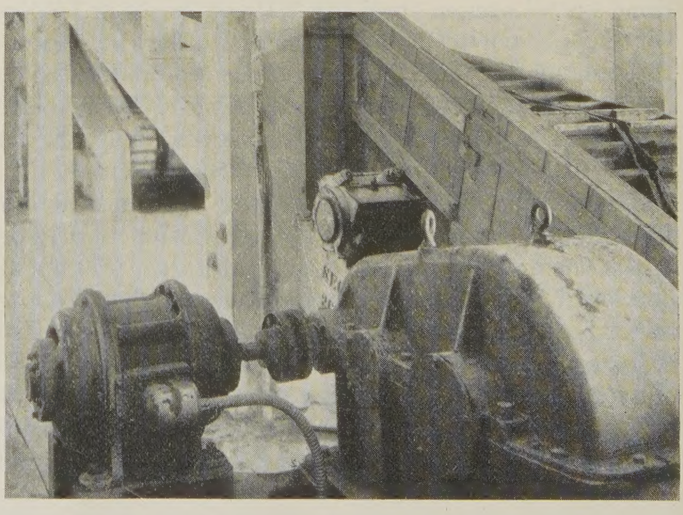
the edger are driven by a 10-hp. series motor through reduction gears and chain drive. These are so proportioned that with no load on the motors the surface speed of the rolls will pull the lumber into the edger as rapidly as good work can be done with the saws. As larger and thicker pieces are sent through the edger the load on the feed works motor increases and automatically slows the feed. Speed characteristics of the 10-hp. motor are such as to provide automatically the proper rate of feed into the saws for the varying thickness of material being sawn.

Among unusual applications of electric power to sawmill machinery is that used by the Weyerhaeuser Timber Company at Mill "C," Everett, Washington. This mill, located approximately three-quarters of a mile away from the power plant, is equipped with individual motor drive throughout, but differs from the usual mill in the respect that no steam is used in the mill for any purpose. The cost of a well-constructed steam line was such that it was decided to use compressed air in place of steam for operating all lifting cylinders, loaders, niggers, etc. A two-stage air compressor, having a capacity of 1,500 cu. ft. of free air per min., driven by a 250-hp. synchronous motor, furnishes all of this compressed air.

For driving the sawmill carriage a slow-speed, d-c., traction-type elevator motor was used, specifications calling for a torque of 12,500 lb. rather than the conventional horsepower rating. Power for this motor is taken from a motor-generator set consisting of a 75-hp., three-phase motor driving two d-c. generators; one to furnish current to the armature of the motor and a smaller one to furnish current for exciting the fields of the generator and the motor. Accurate and quick speed control of the carriage is achieved through a Ward Leonard system which has proved highly satisfactory in every respect.

Armature leads of the motor are connected directly to the armature terminals of the generator, with the full field left on the motor at all times. Hence, speed control is effected by varying the voltage of the generator through field resistance placed in the field circuit of the generator. Reversal of the motor is effected by reversing the fields of the generator. This motor is connected to the carriage through wire ropes, one end of which is securely fastened to the carriage, the other end being fastened to a 30-in. sheave on the motor shaft. The cycle of operation is two revolutions in one direction and then two revolutions in the opposite direction, at a normal rate of from seven to thirteen cycles per min. Because the motor does not set up any windage through the coils by its own revolutions, it was necessary to provide artificial ventilation. This was accomplished by enclosing the motor in a galvanized iron housing through which cool air is forced by a motor-driven fan.

The most recent application found for electricity in the sawmill industry incorporates a Taglibue-Heppenstal moisture indicator. This consists of a case in which is mounted a battery, amplifying tubes and transformers, and an ammeter. Long, flexible leads from this cabinet are connected to two sharp terminals in a small portable handle that the lumber tester carries with him when inspecting lumber. When the points are driven into a piece of wood a current is set up and the value of this current is calibrated as the percentage moisture content of the wood. This method of testing



A double-squirrel-cage, 7.5-hp., 1,200-rev. per min., 550-volt induction motor direct-connected to conveyor drive for "dryness of lumber" has proved so dependable that it now is a standard for testing lumber that is bought with specification calling for a definite moisture content.

Storage-battery locomotives usually of seven-ton capacity having 225-ampere-hour batteries are used for the transportation of lumber from one department to another, where these departments are so arranged that transportation cannot be readily accomplished by crane service. These locomotives run on a 30-in. track, pulling four-wheel roller-bearing industrial cars with train loads as great as 60 tons. They stay in service for eight-hour shifts without recharging of the battery. Small storage-battery trucks and lift trucks are used in some departments for stacking certain items of lumber and for short-distance movement of lumber.

A 7-ton battery locomotive in mill yard service

With modern industrial lighting units it is possible to provide illumination so suited to the work that production can be carried on at night with as high a rate of efficiency as that obtained during daylight operation.

Power required in kilowatt-hours per 1,000 ft. of lumber sawed varies over a wide range, depending upon the sizes of the finished product and the completeness with which the manufacture is carried on.

At a large recently constructed fir mill the power required amounts to 34 kw-hr. per 1,000 ft. of lumber through the mill when sawing the sizes commonly encountered in ordinary construction. The total power consumption of the mill in question amounts to 80 kw-hr. per 1,000 ft. of lumber, including the power required for sawing, for fans at the dry kiln, for planing, and for transportation.

Another large plant handling both pine and fir and producing lumber of various standard sizes shows an over-all power consumption of 78.5 kw-hr. per 1,000 ft. of lumber produced divided as follows:

TOTAL KW-HR. PER 1,000 FT.	
Sawmill	26.6
Planing mill	14.9
Dry kilns	24.5
Lighting and transportation	12.5
Total	78.5

Mercury Rectifiers for Subway Service

Simplification in station design, construction, and operation results from use of mercury arc rectifiers and metal-clad switchgear and bus units; ventilation and noise problems easier to cope with; 9,000-ampere load swings handled by single unit.

By H. M. Van Gelder
Electrical Engineer,
Department of City Transit,
Philadelphia
Member A. I. E. E.

DEPARTING from previously established practise, the Philadelphia Department of City Transit has installed in its most recent substation, mercury arc rectifiers instead of the synchronous converters as installed at its other three substations. This change in equipment selection was brought about partly by recent improvements and developments in rectifier equipment, and partly because some difficulty had been experienced with the synchronous converters flashing over with extreme load variations. Other influencing factors included the better efficiency of the rectifier at light loads, the absence of large rotating parts with their attendant troubles and noise, the absence of commutation of heavy current, better stability under short-circuit conditions, and the relative simplicity of bringing them on the line for service.

Initial construction of Philadelphia's Broad Street subway was started in 1924 and the first six-mile section extending northward from the City Hall was placed in operation in 1928. Initial construction will accommodate four tracks, but at present only two local tracks are installed and in service. To serve this first section, three 6,000-kw., synchronous-converter substations (each containing two 3,000-kw. units—one as a spare) were built at convenient points and of sufficient size to accommodate equipment to serve the expected ultimate subway development.

An extension of the Broad Street subway south from the City Hall, a distance of about three-quarters of a mile, necessitated the construction of a fourth substation to serve an immediate demand for traction power and to serve as a basis for further extension. Experience obtained through two years' operation of the six-mile North Broad Street unit of the subway, indi-

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From "Substations of the Broad Street Subway of Philadelphia," (**No. 30-173**) presented at the A. I. E. E. Middle Eastern District meeting, Philadelphia, Oct. 13-15, 1930.

Substation architectural treatment is in keeping with surroundings

cated by short-time peak loads, would determine the capacity of rectifier units and that such peaks usually lasted less than ten seconds, or during the multiple motor operation on notching acceleration. Consequently the 300 per cent load rating was reduced from a three-minute limit to a one-minute limit, and a unit having a continuous rating of 4,000 amperes at 630 volts, 6,000 amperes at 612 volts for two hours, and 12,000 amperes at 550 volts for one minute, was decided upon. Two units have been installed, one to serve as a spare. The present building will accommodate four units.

Regulation of these rectifiers closely approximates that of the synchronous converters in the original substations, thus making it possible for the two types of substations to be operated in parallel even for extreme fluctuations of load. It is not intended to install both converters and rectifiers in one substation for parallel operation; and there is no necessity for it.

Rectifiers are water-cooled, double six-phase units, containing 12 anodes and equipped with automatic a-c. ignition and excitation, automatic water control, and an indicating vacuum regulator which controls the rotary pump according to predetermined vacuum points. This vacuum regulator also removes the rectifier from service if the vacuum falls before a predetermined value. Thermometers with electrical contacts provide the necessary thermal protection for each rectifier unit. Serving each unit there is a static mercury vacuum pump and two rotary oil vacuum pumps, one of which is a spare. The spare pump was specified as an extra precaution against possible failure of the one piece of rotating apparatus involved in the substation. Operating experience has shown that this rotary pump operates not more than 25 per cent of the time under present conditions.

The only cooling water required for the substation is for the rectifiers and the supply for this service is taken from two different city mains to insure availability of continuous supply. Because of the relatively light continuous load and the prevailing low cost of water, it has been found to be cheaper to waste the water than to provide cooling equipment for its re-circulation.

Transformer cells or rooms are provided at each of the four corners of the building, an arrangement which permits each transformer cell to have two outside openings at ground level and a large individual ventilator in the roof. One of the ground-level openings contains adjustable louvers and the other has a vertical lift door which gives entrance from the street; thus natural ventilation from two directions is provided. Since noise is practically completely absent from the equipment of this substation, no special precautions had to be observed in connection with sound-proofing and no special ventilating problems were involved.

Another departure in design in this substation was the use of an armor-clad bus and switchgear structure affording complete circuit accommodation for the incoming 13.8-kv. circuits, bus, oil circuit breakers, instrument transformers, disconnecting devices, etc. All cable leads to and from the armor-clad structure are lead-covered and wiped permanently to potheads which form a part of the structure itself. One attractive feature of this type of equipment is that all relays and connections are self-contained and mounted on the various switchgear units. Also, each armor-clad structure is completely built and assembled in the factory, requiring no masonry structure in the station except for foundation blocks; this simplifies both station design and station construction.

The subway d-c. power demand is of such a fluctuating character and, at present, has such a low sustained value that it was found of little use in forming or baking-

Two 4,000/12,000-ampere rectifiers in subway service; one a spare out the rectifier. To furnish a continuous load for this purpose a water rheostat which will absorb 1,200 amperes has been installed to operate in parallel with the traction load. If necessary, the rectifier can be operated six-phase or three-phase at times of bake-out to increase the current per anode.

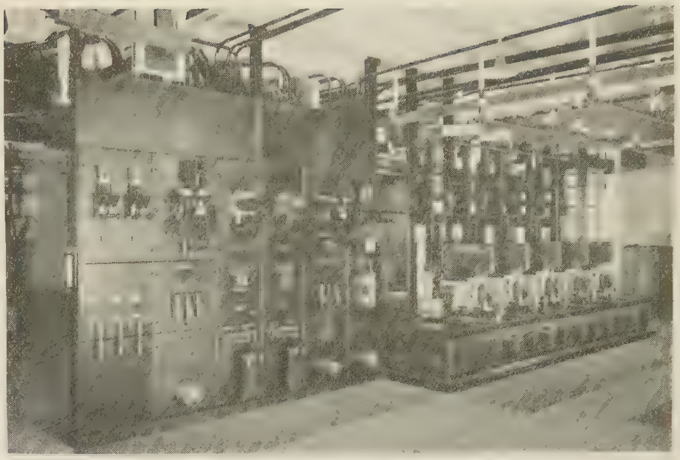
All apparatus in the substation is controlled from the main switchboard in an operating office on the rectifier floor. All other switchboards and all 630-volt d-c. circuits are in the basement. The d-c. connections from the cathode of the rectifier pass directly through the floor to the rectifier switchboard below. This board contains a remote-control positive switch and a special quick-acting circuit breaker for each rectifier, with auxiliary switches and interlock so arranged that when the 13.8-kv. oil circuit breaker of the rectifier unit is closed, all other starting functions are performed automatically. Thus the operator has only to close the positive d-c. circuit breaker control switch to bring the rectifier on the bus.

The four neutral connections of each main transformer are carried to the basement through wall ducts to its interphase transformer located immediately adjacent to the negative bus. The neutral lead of this interphase transformer constitutes the negative connection of the rectifier nuit and is connected to the negative bus.

From the rectifier switchboard in the basement the main 630-volt positive circuit runs directly to the positive bus; thence through the high-speed circuit breakers to the feeder switchboard and out through underground cables and conduits to the air circuit breakers and contact rail in the subway. Thus, all 630-volt power circuits are kept off the main floor. Furthermore, all of these circuits are run in the basement by means of copper bars, no cable being used until the outgoing underground cables are reached.

The station auxiliary switchboard in the basement has its principal operating circuits controlled from the main control board in the operating office. A 125-volt storage battery supplies energy for the control circuits while the auxiliary a-c. circuits for the rectifier units have three separate sources of power to insure continuity of service—an auxiliary station transformer fed from the 13.8-kv. main bus, and a second auxiliary transformer fed from either of two 4.6-kv. lighting feeders brought into the station from different power sources.

Metal-clad switchgear units simplify construction, operation, and maintenance



Rectifier switchboard and high-speed breakers in Philadelphia substation

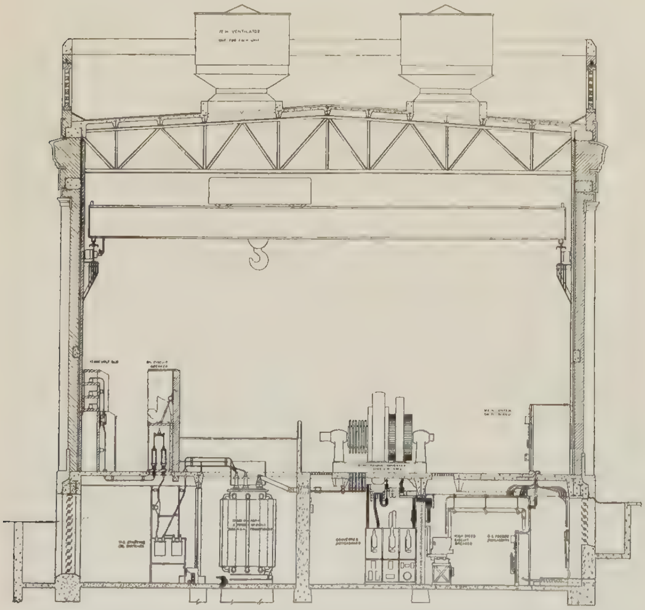
Since it was placed in operation April 20, 1930, this heavy-duty rectifier installation has functioned satisfactorily. During early operation a few back-fires occurred doubtlessly due to insufficient baking-out of the rectifier before heavy overloads were carried. However, no damage was done and now loads of 10,000 amperes are taken by one rectifier unit. There has been no signal or telephone interference experienced as the result of the operation of this substation. Telephone circuits in the district are carried in underground cables.

Since the converter stations also are relatively new and represent current practise a brief outline of their equipment and operating characteristics may be of some interest. At present there are installed in each of these original substations duplicate compound-wound 360-rev. per min. 60-cycle converters, which were characterized at the time of their installation as being the largest that had been built for 630-volt traction loads. The actual rating of each machine was 3,000 kw. at 630 volts for continuous duty when supplied with six-phase 60-cycle power at 100 per cent power factor; 4,500 kw. at 630 volts for two hours, and 6,000 kw. at 560 volts for three minutes.

The starting and control system for these converters has some unique features; it was designed for star-delta starting by the automatic switching of the high-voltage windings of the transformers; for assuring correct polarity; to avoid error in brush position; and to prevent closing a dead machine onto the bus. The sequence of operations when starting the converter is as follows: To insure correct polarity, the field is excited from the control-battery circuit before the main oil circuit breaker can be closed by the control switch. The closing of the oil circuit breaker completes the closing circuit of the star oil switch, if the brushes on the converter are raised. When the converter has attained synchronous speed a relay bridges a gap in the tripping circuit of the star oil switch, and this circuit is completed by another relay which closes at a definite value of the field current after the field switch has been thrown over to self-excitation. The star oil switch on opening completes the closing circuit of the delta oil switch, provided the oil circuit breaker continues closed. The oil circuit breaker is trip-free during these operations so that full protection is assured. The d-c. switches and circuit breakers are electrically operated, but before the positive switch can be closed the delta oil switch must be closed, brushes lowered, equalizer switch closed, and positive circuit breaker closed.

The oil circuit breaker will open on over-current or low voltage and, by interlock control, automatically opens either the star or delta oil switch and the d-c. circuit breaker. The d-c. breaker opens on over current, reverse current, over speed, or under voltage, and upon opening, opens the positive switch and the equalizer switch.

In the event of a converter flashover, a ground relay opens both the oil circuit breaker and the d-c. breaker; thus it may be seen that many of the operations are automatic, the operator performing only the initial movement of a sequence. The design also assures speed of operation and prevents an operator from making mistakes in putting a converter on the line. At the time of an unexpected failure of the power supply to a substation, the operator was able to clear all feeder circuits and auxiliaries, ordered power on again, started up the station, and established full d-c. feeder service in three minutes.



Section through a converter substation where ventilation and sound-proofing must both be assured

These three substations have been in operation for over two years and all equipment has functioned very satisfactorily. The converters have flashed over occasionally but have not averaged more than two or three per year per machine; and when they do occur, the damage is slight and usually the machine does not have to be left out of service. The flashovers generally occur at times when a heavy load is suddenly cut off, particularly where a limited short circuit occurs which does not open the high-speed breaker but clears itself or is cleared by a subway air circuit breaker. Apparently the flashovers are due to large synchronizing currents caused by angular displacement of the armature after heavy momentary load.

One operator and a helper are on duty in each station at all times.

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Electrolysis Survey at Louisville, Ky.

Cooperative committee finds that electrical drainage is only a partially effective measure in the protection of pipe systems.

By W. C. White

Southern Bell Tel. & Tel. Co.
Atlanta, Ga.

PREVIOUS to 1926, no concerted action in respect to the electrolysis of underground metallic structures in Louisville had been taken, although the individual action of the water, gas, and electric and railway companies had served to mitigate specific cases of trouble. Realizing that the electrolysis problem could be solved only by securing complete data on all of the underground metallic structures, a conference of the public utility companies was held which resulted in the formation of the Louisville Electrolysis Committee in which all of the public utilities were represented. A citywide electrolysis survey and test procedure were planned the expense of which was prorated among the interested utilities.

A potential survey was made of the entire city, tests being made at over 600 points. It was found advantageous to use recording meters, and twelve of the smoked chart types were mounted on a truck with suitable switching arrangements for connecting them

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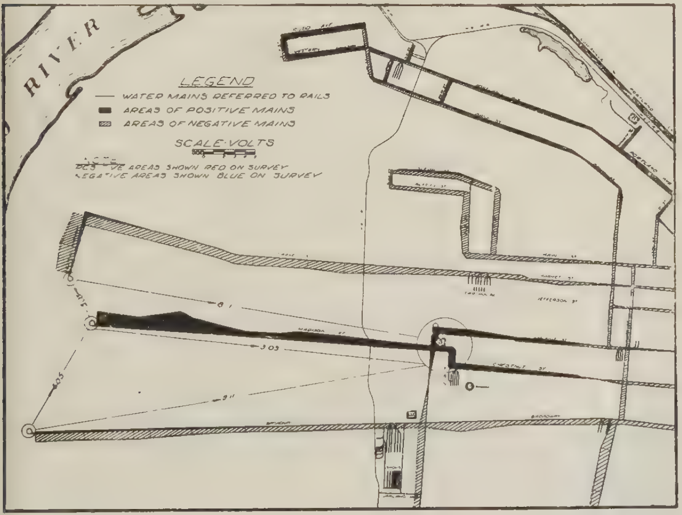
From "A Cooperative Electrolysis Survey in Louisville, Ky.," presented at A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930. (**No. 30-189.**)

between various structures and between structures and earth.

A current survey of sub-surface structures supplemented the potential survey in determining probable hazardous conditions and furnished valuable data for consideration in the application of remedial measures.

Specially equipped truck typical of those used in Louisville, Ky., electrolysis survey

A current survey of cable systems is a relatively simple procedure and in a great many cases will indicate hazardous conditions where they would not otherwise be located. Approximately 72 such test stations were established on the underground systems of Louisville and 24-hr. records were made of the stray currents. Numerous measurements were also made of track-potential drop and track-potential gradients.



A graphical method of presenting electrolysis survey data for joint study

Soil resistivity tests were made on 180 samples which differed widely, but averaged about 5,000 ohm/cm.

Test data were assembled on cards at the time when current or potential tests were made. A card was prepared giving the number and location of the test point and cross-referenced with the corresponding records. On the reverse side of this card was shown a diagram of the test point and the location of structures to which connections were made. This was done in order that any test could be repeated with identical connections at any time. Those portions of the data capable of graphical presentation were plotted on maps, the areas indicated by the positive potential ordinates being colored red and that of the negative potential ordinates, blue.

When sufficient data were obtained in any section from which definite conclusions could be reached, the electrolysis committee, which met weekly, recommended mitigative measures in order that these might be applied as the survey progressed.

No quantitative results are given, but the success of the methods outlined in improving the general electrolysis conditions in the city has resulted in the continued active existence of the committee which functions as a central clearing house for the investigation of all matters relating to electrolysis in Louisville.

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Fog-Type Insulators Eliminate Transmission Line Flashovers

According to A. C. Nielsen Company, engineers, Chicago, and J. E. Woods and E. T. Ankele, respectively chief engineer and operating engineer for the Central Power & Light Company, San Antonio, Texas, Lapp standard fog-type insulators have been instrumental in solving a troublesome transmission line problem on the power company's 17-mi., 66-kv. transmission line between Sinton and Robstown, Texas. The line in question is subject alternately to dust and salt fogs, and for some time prior to its reinsulation there occurred an average of some ten insulator failures and consequent service interruption. Analysis of maintenance costs showed an average expenditure of of $152.50 annually to cover necessary replacements, and this together with troubles arising from interruptions to important service brought about a reinsulation which was completed about two and one-half years ago. At that time the 66-kv. pin-type units previously in service were replaced each by three No. 5805 fog-type units. It is stated that insulator failures due to arcover have been eliminated entirely.

The line in question is carried on H-frame structures for the most part, using 22-ft. wooden crossarms giving a 10-ft. 6-in. spacing between conductors. Supporting I-bolts of the insulator strings are grounded to a copper strip running along the top of each crossarm and grounded by wires extending down the pole and wrapped around the base of the pole before erection. The line is rated at 15,000 kv-a., 66 kv.

Railroads *versus* Transmission Lines

Double use of railroad right-of-way permits high-voltages transmission lines to penetrate closely built-up area; also effects economies through coordination in railroad electrification and transmission construction.

By W. W. Woodruff and G. I. Wright

Superintendent Aerial Lines
Philadelphia Electric Company
Associate A. I. E. E.

Engineer Electric Traction
Reading Company, Philadelphia
Member A. I. E. E.

BECAUSE of a combination of factors, Philadelphia has been obliged to take several steps in the matter of utilizing railroad rights-of-way for electric power transmission purposes and probably has made advance further along these lines than any other city in this country.

While in other localities, the same factors may not be operative with relative importance it is probable that in the immediate vicinity of any large cities there are, or will be, a combination of circumstances which make the utilization of railroad rights-of-way for electric power transmission purposes both essential and expedient.

It is felt that the results obtained in Philadelphia have been highly satisfactory—beneficial to both the railways and the electrical industry; a wider knowledge as to the general features should be of interest to others.

In order to make the situation clear it will be well to review the various factors involved, briefly tracing developments through several stages.

Philadelphia is located on a peninsula formed by the junctions of the Schuylkill and the Delaware Rivers. South of the Schuylkill River there is an industrial development which extends through Chester and Marcus Hook to the State of Delaware. West of the Delaware River there is an urban section of congested development from one to six miles deep, extending for about twenty miles along the water front. Back of this strip is an area of suburban and semi-rural development forming a belt probably some twenty miles deep and extending from the vicinity of Trenton to the Mason-Dixon Line.

The main steam plants of the Philadelphia Electric Company supplying this region with electrical energy are of necessity located along the Delaware River. A glance at a map of the territory indicates that plants along the Schuylkill would be better strategically for feeding this specific territory. However, large stations on this river are impractical because of the fact that the river flow is comparatively small. The oldest station of the Philadelphia Electric Company is located on the Schuylkill and is still in operation, but for a number of years it has not been advisable to add to its generating capacity and it is doubtful if it will ever be expedient to rebuild it. Consequently, a major problem of means to carry power into Schuylkill station has been to establish other strategic points of large capacity supply, and to tie these in with the larger generating stations in the territory and outside sources of supply.

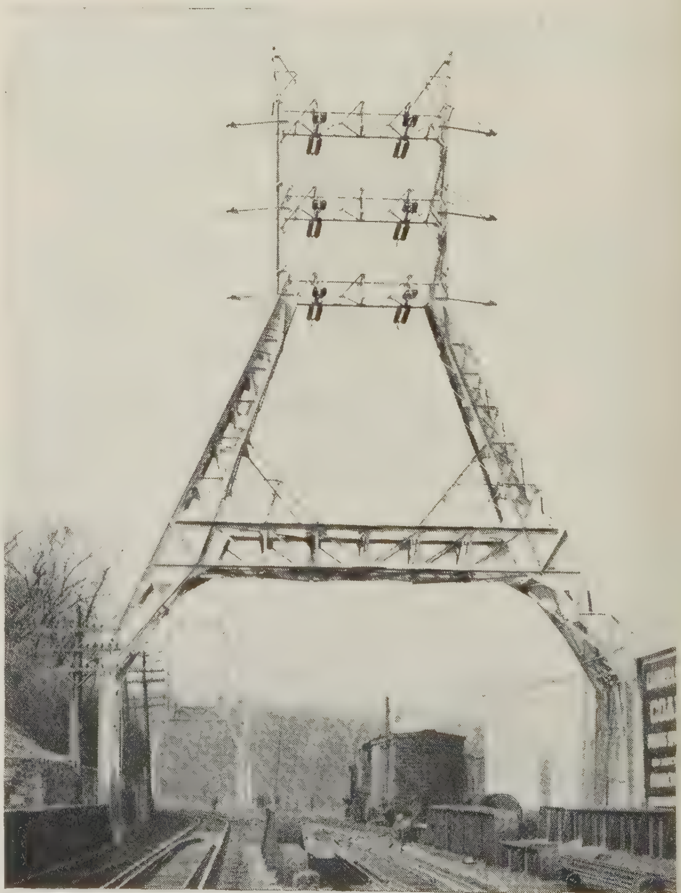

Fig. 1. A 66-kv. four-circuit tower on a restricted right-of-way of the Reading railroad

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From "Utilization of Railroad Rights-of-way for Electric Power Transmission and Coordination with Railroad Electrification," (**No. 30-174**) presented at the A. I. E. E. Middle Eastern District meeting, Philadelphia, Oct. 13-15, 1930.

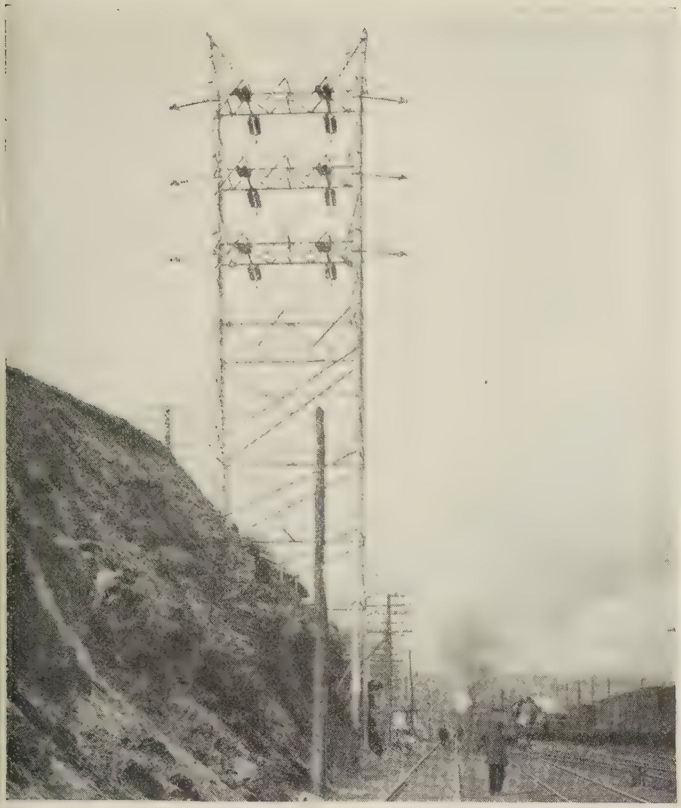


Fig. 2. Four-circuit 66-kv. tower on Reading railroad right-of-way where space is available outside of tracks

In considering the transmission of large blocks of power from outside sources into these urban centers, securing a satisfactory right-of-way to the economic centers of distribution is frequently almost impossible. Through highly developed districts various railroad lines form the only feasible routes. Practically all rights-of-way are railroad property.

The first major problem of this kind in Philadelphia originated about 1915-16, when in order to back up the older station and take advantage of the more economical generation at the newer station it became essential for the electric company to have a 66-kv. transmission line between Schuylkill station in Philadelphia and the new Waterside station in Chester.

The only feasible route between these two stations was along a freight line of the Reading Railroad and a short section of the Pennsylvania Railroad which ran between Philadelphia and Chester. Practically all the property along this railroad route was either already developed or had so much of potential value for future manufacturing sites that its purchase for transmission lines and the securing of a permanent right-of-way over it, were out of the question. Consequently, the transmission line was built largely on the railroad right-of-way. The type of agreement between the companies was one which might naturally be expected in a period when considerable difference of opinion regarding wire crossings, (Pennsylvania General Order No. 13 and other items) existed between the railroads and power companies, and naturally, the agreements had a revocation clause, as was then customary.

A similar situation developed in 1924 in connection with a project of the electric company's for interconnection between Philadelphia and Trenton. The district immediately adjacent to the Richmond Station, from which circuits must run, was so highly developed that the only expedient was to run underground cable for a distance of about four miles and then construct a 66-kv. steel tower transmission line on the Oxford branch of the Pennsylvania Railroad for a distance of about five miles.

The electric company was loath to invest several hundred thousand dollars on a right-of-way where it had no really permanent and irrevocable rights; at the same time, the railroad company was loath to grant any permanent rights on its property owned for transportation purposes. In this case the question was solved by the electric company purchasing in fee simple the additional property outside the line of proposed tracks, which it had been necessary for the railroad company to secure for cutting and filling in road-bed construction. In return the electric company gave to the railroad the right to cross its fee-simple right-of-way to reach adjoining industrial developments wherever necessary, receiving certain rights to maintain wires overhanging the railroad right-of-way.

This agreement was greatly preferable to the revocable type mentioned previously, and was obviously a step forward in cooperation, but could hardly be called complete coordination.

The lines mentioned here were of comparatively small capacity. A much more serious situation developed when it was necessary for the electric company to make plans for bringing into its metropolitan system the Conowingo power output. In this project transmission had to be provided not only for Conowingo power itself but also for power involved in the interconnection between the Philadelphia Electric Company, Public Service Electric and Gas Company of New Jersey, and the Pennsylvania Power & Light Company. Transmission capacity of about 600,000 kw. was required.

Obviously it was necessary to deliver this amount of power well into the highly developed sections of the city at as high a voltage as practicable; and it was equally obvious that it was desirable to bring it in as far as possible on aerial construction. Initially, it was quite evident that a considerable portion of this power must be distributed to the various generating stations in the city by means of 66-kv. underground cable, but on account of the investment, this length of cable must be kept at a minimum.

The only feasible route into the highly developed territory to a point desirable from a distribution

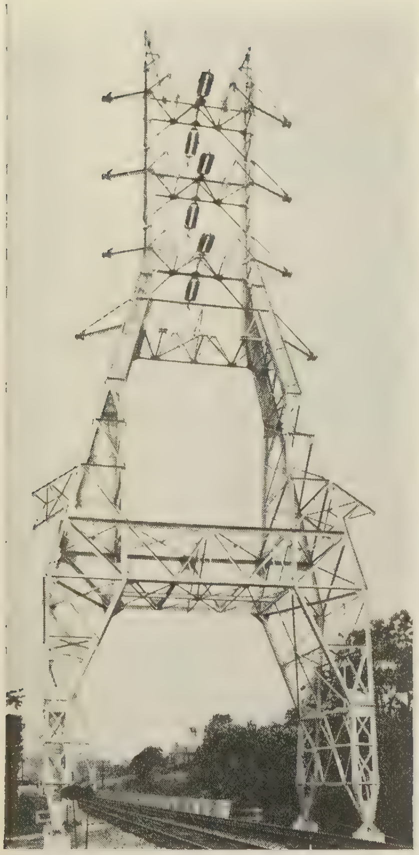


Fig. 3. (Left) Latest type of tower used on restricted Reading right-of-way, providing for three 66-kv. power circuits and four railroad circuits

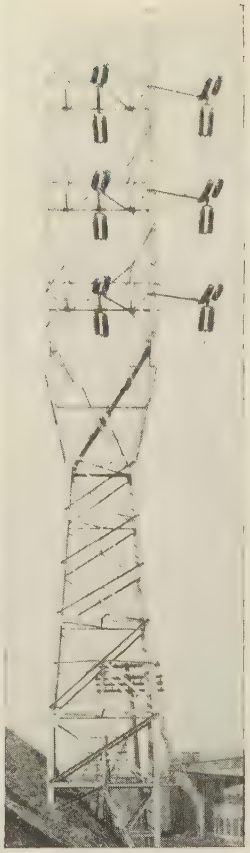


Fig. 4. (Right) Special two-circuit tower for use along side of railroad tracks

standpoint lay along two lines of the Reading Railroad paralleling the Schuylkill River from a point slightly inside the city limits, the latter point being accessible by the conventional aerial construction on private right-of-way.

The situation required an agreement which would be mutually satisfactory to the railroad company and the electric company. Obviously, a project forming so vital a link in so large and important an undertaking must have a permanent status; its continuity must not depend upon any revocable clause or other consideration which did not guarantee permanent and perpetual rights to the electric company. It was equally obvious that the railroad company was in the same situation and must preserve permanent rights for maintaining its operating facilities, as well as the ability to change and increase those facilities as conditions required.

Occupation of railroad right-of-way for electrical transmission can in no wise be considered similar to the utilization of public highways. Due to its prior development the railroad company owns outright and in fee simple the major portion of its right-of-way; consequently, it gives up none of the rights invested in the ownership of property or in any way limits itself in the development of its facilities.

With the Reading Railroad situation, these factors were readily appreciated at the beginning; it was obvious that the conditions required consideration and the finding of a satisfactory solution for—

(a) the designing of the structures of strength adequate to meet severe conditions of climatic loading, and the rules and regulations of any public service body;

(b) designing and locating the structures so that they woudl not interfere with the operation of the railroad company's existing or proposed tracking and facilities;

(c) locating and designing structures to serve as supports without interfering with supports for the future railroad electrification circuits;

(d) in the event of alteration, augmentation, or reconstruction of the railroad facilities, to provide for a joint study of the situation for the most economical means of improvement;

(e) reconstructing or altering the signal and communication system so as to secure satisfactory operation under inductive coordination conditions of future railroad electrification and train control;

(f) the apportionment of costs resulting directly or indirectly from occupation of the railroad company's right-of-way by transmission circuits the electric company's;

(g) the determination of a rental charge for rights of occupation.

The final agreement recognized all these factors. The advantage to the electric company is chiefly a permanent right-of-way through a district precluding independent ownership from either a financial or a public policy point of view. But the electric company assumes a considerable liability.

The benefits to the railroad company are;

(a) the control and coordination of the physical and inductive conflict which might arise were electric lines to be located off the right-of-way but parallel to it;

(b) obtaining supports for its electric transmission and catenary circuits;

(c) the alteration of all signal and telegraph facilities to be unaffected by the operation of the electric company's facilities also safe-guarding railroad electrical operation of trains;

(d) an annual rental charge for occupation of right-of-way.

One important feature should be remembered; were the electric company obliged to purchase a right-of-way, a considerable portion in this case would have either paralleled or been in close proximity to the railroad right-of-way. While the feature of physical interference would have been decreased, the inductive interference situation would have been almost the same as exists with the transmission circuits on the railroad right-of-way.

It is not intended to give here a detailed description of the structural features; they are of greater interest to the structural than the electrical engineer. Only a few points of major interest will be mentioned.

The general electrical features for the electric company's transmission circuits are very much the same as those now used for 66-kv. lines on the conventional steel-tower type construction; that is, the vertical separation between conductors is approximately 10 ft., the minimum clearance to steel work 2½ ft., with the circuits protected by ground wires to avoid lightning disturbances.

In the original installation of about 4½ miles on the main line and Richmond branch of the Reading Railroad, provision was made for four three-phase circuits, it being originally intended that two of these circuits would be reserved for the electric company and the other two positions for the railroad company. (Fig. 1) With the further development of the railroad company's plans it proved feasible to change the formation of the top of the structure so that on the recent Norristown branch construction three three-phase transmission circuits were provided for the electric company and space for two two-wire circuits for the railroad company. (Fig. 3)

To meet the requirements necessitated by future track construction, right-of-way, etc., several expedients in the design of structures were necessary. For the greater part of installation on the main line and Richmond branch, located on a cut on the side of a precipitous slope, there was sufficient room on the side of the cuts and fill to place the structures outside the line of any present or proposed tracks, (Fig. 2); but as the more congested portion of the city was approached, the right-of-way conditions naturally became constricted and in some locations the conditions could be met only by a bridge type of construction which completely spanned a four-track roadway. At other locations it was possible to meet the requirements by dividing the construction, placing the towers on opposite sides of the right-of-way with one circuit going through the center of the structure and the other circuit overhanging the roadway. (Fig. 4)

In the construction on the Norristown branch of the Reading railroad the right-of-way is very much constricted for about the first three miles from termination of the line. Throughout this section it was necessary to utilize the bridge type of construction over a proposed four-track roadway. This roadway involved a project to eliminate a grade crossing and several interesting situations had to be considered.

In certain portions a retaining wall was to be built and the design of foundations for transmission structures must necessarily be coordinated with the design of the retaining wall, the tower footings forming portions of this wall. In another location a steel viaduct was to be constructed so designed at the necessary location that the steel work for the transmission structures could be attached directly.

One circuit of the new construction should now be in operation, service on the initial construction being of something over two and one-half years standing with very satisfactory results.

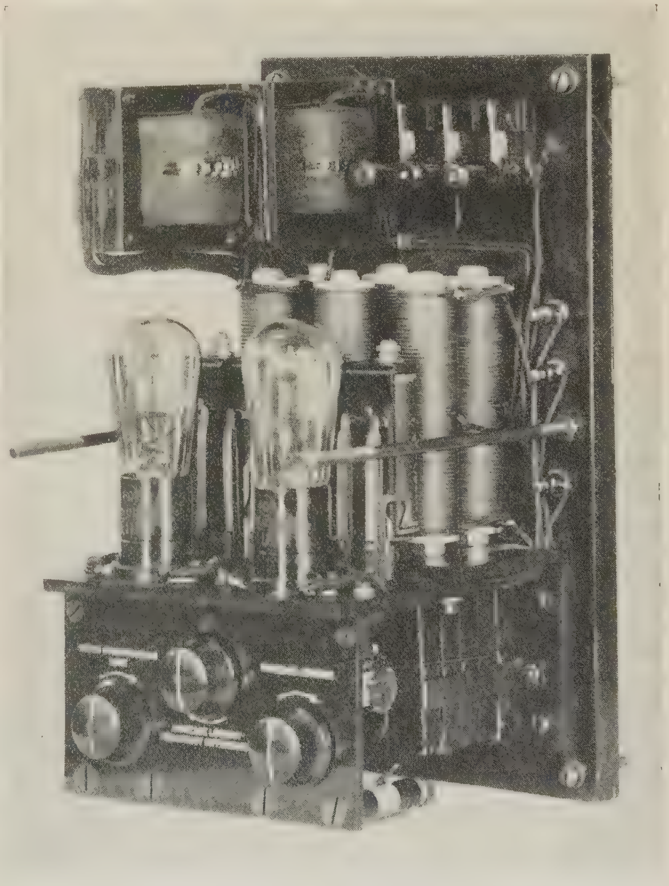
By words of conclusion, transportation of coal from the mines to urban centers, and of electrical energy from hydroelectric supply sources to these same centers, affect all industry and directly or indirectly a large proportion of the whole country's population.

The more intensive the use of rights-of-way for the transportation of these commodities and the successful coordination of the problems involved, the greater the tribute to the managements of the respective companies. Cooperation cannot but result in substantial public benefits.

◆ ◆ ◆

Synchronizing With Vacuum Tubes

THE day's tense moment in the old time power plant came when big machines were synchronized—pilot lights undulating dim and bright, the pointer turning slowly and more slowly; an instant of resolve and the switches slammed in.



No moving parts in this synchronizer

Then either a protecting grunt from the machines, or a sigh of relief from the operator.

All this is gone by, and now even the mechanical synchronizers of recent years may be replaced by a Westinghouse vacuum tube arrangement of 1930 which having no moving parts and demanding but five volt-amperes can draw its energy from a condenser bushing—a substantial advantage over mechanical synchronizers which, requiring 66 to 150 volt-amperes, must be fed from expensive potential transformers. The low power consumption of the new synchronizer is partly due to the use of hipernick in small transformers embodied in it.

The principle of operation involves current based on the beat frequency between the two circuits rectified and used to control the grids of the vacuum tubes. The two simple adjustments are made by radio type rheostats. One changes the frequency difference at which it will synchronize (usually $^1/_6$ cycle); the other adjusts the angle of advance to allow the circuit breaker to close at exact synchronism.

The new synchronizer is twice as accurate as the most skilful human operator, and should last longer if calculation goes for anything; its only mortal elements being two standard radio tubes good for 1000 continuous hours and used but five minutes a day.

◆ ◆ ◆

Saturation Phenomena in Potential Transformers

Experiences with grounded-neutral Y-connected potential transformers on ungrounded systems emphasize certain dangerous "saturation phenomena" which frequently occur. Two applications are outlined here and preventive measures recommended.

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METHODS for preventing the occurrence of the peculiar and dangerous "saturation phenomena" caused by the two applications of Y-connected potential transformers to three-phase, three-wire systems are outlined in this paper. One of the systems operates at 12 kv., 60 cycles, and the other operates at at 110 kv., 25 cycles. In each case the neutral of the potential transformer bank was grounded but the section of the system involved was ungrounded. Although not in accordance with the best practise for power transformers, (because of the apparent suppression of the third harmonic and its multiples of exciting currents), such applications have been made for the affording of protection of equipment against grounds, the economy resulting from the use of *L/N* instead of *L/L* (abbreviations *L/N* for "line-to-neutral" and *L/L* for "line-to-line" are used) potential transformers and the maintenance of the isolated-phase scheme for such installations.

It may not be generally appreciated that such applications frequently endanger connected equipment in addition to creating special relaying and synchronizing problems. Sufficient data are included to illustrate the inherent danger and to afford a basis for the "general recommendations" made. (For discussions from theoretical standpoints, companion papers, "Physical Nature of Neutral Instability," by A. Boyajian and O. P. McCarty, and "Theory of Abnormal Line-to-Neutral Transformer Voltages," by C. W. La Pierre, are relied upon. These papers were presented at the Southern District meeting in Louisville, Ky., Nov. 19-22, 1930, and are reviewed elsewhere in this issue.)

The potential transformers were designed for normal operation at *L/N* voltage and for emergency (two-hour) operation at *L/L* voltage. Temporary operation in case of a ground on one line of the ungrounded section, which would apply *L/L* voltage to two of the potential transformers, was thus provided. Their ratings are given in Table I.

TABLE I
RATING OF POTENTIAL TRANSFORMERS

		Volts	
Cycles	Volt-amperes	Operating (*L/N*)	Circuit (*L/L*)
60	200	7,200:120	12,000
25	1,000	63,500:63.5	110,000

SUMMARY OF RESULTS

The peculiar and dangerous saturation phenomena here described briefly were obtained frequently when voltage was applied to grounded-neutral, Y-connected potential transformers on temporarily ungrounded systems by closing an oil switch; at other times, the anticipated normal results consisting of balanced *L/N* voltages equal to approximately 58 per cent of the applied *L/L* voltages were obtained under the same

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From "Experiences with Grounded-Neutral Y-Connected Potential Transformers on Ungrounded Systems," (**No. 30-182**) presented at the A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

TABLE II
12-KV., 60-CYCLE SYSTEM
7.2-KV. POTENTIAL TRANSFORMERS
COMPARISON OF PHENOMENA *A*, *B*, AND *C* WITH NORMAL SECONDARY VOLTMETER READINGS
(Approximate Primary Volts = Tabulated Volts × 60)

	Line-to-Line (*L/L*)			Line-to-Neutral (*L/N*)			
Per cent*	1-2	2-3	3-1	1-*N*	2-*N*	3-*N*	Phenomenon
Capacitance to ground of 12-kv. circuit, 0.035 μf							
94	194.6	194	196.5	113	115	111	
94	194.2	194	195.2	195	†	180	*A*
100	206	206.5	206.8	195	†	183	*A*
100	206.5	206	207.4	†	174	194	*A*
100	206.5	206.5	208	187	187	†	*A*
104	215.2	215	218	125	126	122	
104	213.4	212.8	215.4	194	†	180	*A*
104	215.8	214	217.6	123	125	122	
104‡	209	207.6	211.5	334.5	331.5	336	*B*
Capacitance to ground of 12-kv. circuit, 0.845 μf.							
100	207	208	209.2	120	119	122	
100‡	197.5	199	200	147	148	149	*C*
113	233.5	235	234.8	134	133	138	
113‡	224	225	227	155	155	155	*C*

*Approximate—based on potential transformer "rating" of 208 volts *L/L* (= 1.73 × 120 volts *L/N*).
†Volts too low to read on 600-volt voltmeter.
‡Supply voltage practically unchanged from previous reading.

system conditions. The operating conditions are indicated in Fig. 1a when "oil switch *I*" is open and voltage is applied to "ungrounded section *U*" from "source *II*" by closing "oil switch *II*." Also, test connections are given in Fig. 3. The phenomena will be considered under three classifications, *A*, *B* and *C*; (a fourth classification *D* covers a somewhat special case). The phenomena are represented in Fig. 2 and are shown in Figs. 4, 5, 6, and 7. Representative secondary voltmeter readings obtained are given in Tables II and III.

Phenomenon *A* consists of a displacement of the neutral (or ground) of the potential transformers from its normal position at the center of gravity of the delta-voltage triangle to a position near any vertex; the displaced neutral may be either inside, on the edge, or outside of the triangle. Approximate *L/L* voltage then appears on two of the potential transformers, while a small voltage of very distorted wave shape appears on the third potential transformer. Phenomenon *A* occurred frequently under some conditions (but not at all under other conditions) on both the 12- and 110-kv. systems.

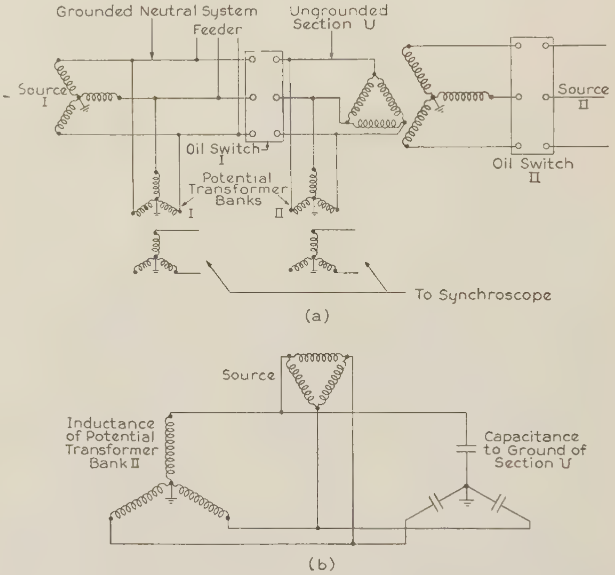
TABLE III
110-KV., 25-CYCLE SYSTEM
63.5-KV. POTENTIAL TRANSFORMERS
COMPARISON OF PHENOMENON *A* WITH NORMAL SECONDARY VOLTMETER READINGS
(Approximate Primary Volts = Tabulated Volts × 1,000)

	Line-to-Line (*L/L*)			Line-to-Neutral (*L/N*)			
Per cent*	1-2	2-3	3-1	1-*N*	2-*N*	3-*N*	Phenomenon
100‡	110.3	111.8	109.5	64.1	64.2	64	
110	122.7	123.8	121.4	70.4	71.3	70.5	
110	119	121.8	119.2	138.2	22†	129.8	*A*
Duplicate bank of potential transformers added							
100	110.2	111.9	109.8	63.5	64	63	
100	110	110.5	108.3	16†	113.8	122.5	*A*
110	122.2	123.2	122	70.3	71.2	70	
110	121.5	121.7	120.8	13†	114.3	121	*A*

*Approximate—based on potential transformer "rating" of 110 volts *L/L* (= 1.73 × 63.5 volts *L/N*).
†Estimated value.
‡Phenomenon *A* not obtainable.

Phenomenon *B* consists of an oscillation at double frequency of the neutral (or ground) of the potential transformers outside of the delta-voltage triangle. Equal or balanced voltages of unsymmetrical wave shape and about 2.7 times normal magnitude appear on the three potential transformers. These voltages are accompanied by balanced exciting currents of sharply peaked wave shape and about 10 times rated full-load current in magnitude; operation well up on the saturation curve is indicated thereby. Distinctly audible beats occur with a frequency of from about 30 to 170 per minute; excessive corona also occurs. Phenomenon *B* is represented in Fig. 2c.

Phenomenon *B* started frequently under some conditions but held only long enough to take instrument readings at rated *L/L* voltage or higher on the 12-kv. system; and even then, only at certain times.



(a)

(b)

Fig. 1. Schematic Diagrams: (a) typical system connections, (b) elements of circuit U

Phenomenon *C* consists of an oscillation at half the frequency of neutral (or ground) of the potential transformers inside of the delta-voltage triangle. Equal or balanced voltages of unsymmetrical wave shape and about 1.2 times normal magnitude appear on the three potential transformers. These voltages are accompanied by balanced exciting currents of sharply peaked wave shape and about 15 times rated full-load current in magnitude; operation at a point on the saturation curve well beyond that for phenomenon *B* is indicated thereby. Distinctly audible beats occur with a frequency of about 240 per minute. Phenomenon *C* occurred frequently under one condition only on the 12-kv. system.

The occurrence of phenomena *A*, *B*, and *C*, as shown by sustained instrument readings, was prevented in all cases by adding sufficient secondary burdens of resistance. The values (at 120 volts) of the protective resistor burdens required on the 12-kv. system are as follows: phenomenon *A*, at all voltages tried, 72-volt-amperes; phenomenon *B*, about 20 volt-amperes; phenomenon *C* at rated *L*/*L* voltage, 72 volt-amperes. A burden of 72 volt-amperes, therefore, was provided for each transformer. Similarly, the burden values (at 63.5 volts) required on the 110-kv. system are: phenomenon *A* (and *B*) at all voltages tried, 900 volt-amperes per transformer with one bank of potential transformers or 600 volt-amperes per transformer with two banks of potential transformers.

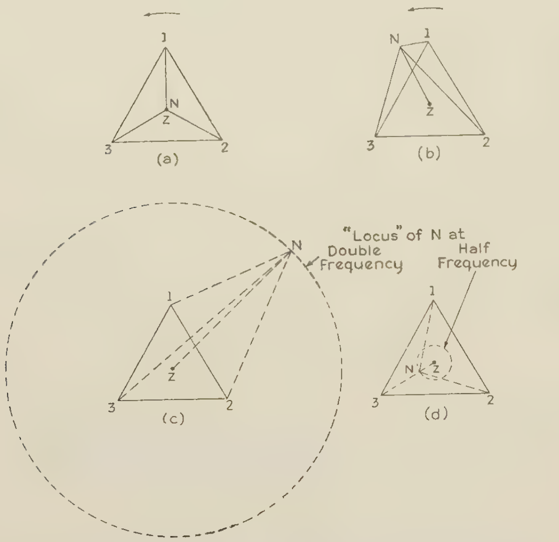


Fig. 2 Representations of voltage phenomena by means of vectors

(a) Normal condition, neutral *N* coincides with center of gravity *Z* of delta-voltage triangle 1-2-3. (b) Phenomenon *A*, neutral *N* located near one vertex of delta-voltage triangle 1-2-3. (c) Phenomenon *B*, neutral *N* oscillates at double frequency outside of delta-voltage triangle 1-2-3. (d) Phenomenon *C*, neutral *N* oscillates at half frequency inside of delta-voltage triangle 1-2-3.

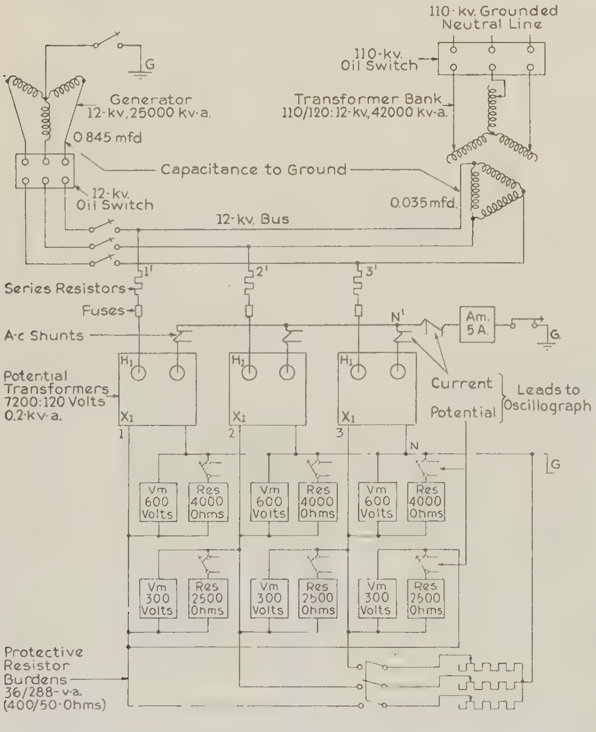


Fig. 3. Schematic diagram of connections for tests on 12-kv., 60-cycle system

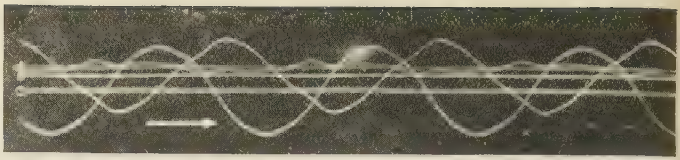


Fig. 4. 7.2-Kv. potential transformers—phenomenon A

Curve *A*, voltage 2-*N*; curve *B*, voltage 3-*N*; curve *C*, voltage *N*-1

In further tests made on the 12-kv. system (capacitance to ground 0.035 μf.), phenomena *A* and *B* also occurred when a bank of 13.2-kv. potential transformers was connected in multiple with the bank of 7.2-kv. transformers; however, neither *A* nor *B* occurred when the 7.2-kv. bank was disconnected.

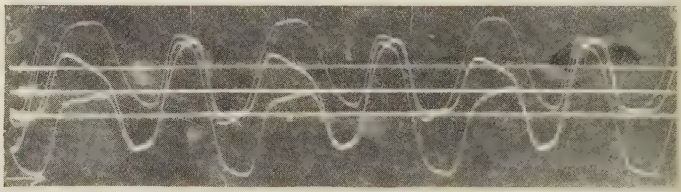


Fig. 5a. 7.2-Kv. potential transformers phenomenon B

Curve *A*, voltage 3-*N*; curve *B*, voltage 2-*N*; curve *C*, voltage 1-*N*

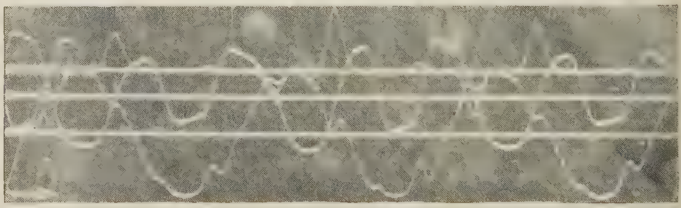


Fig. 5b. 7.2-Kv. potential transformers—phenomenon B

Curve *A*, current line 2′; curve *B*, voltage 2-*N*; curve *C*, voltage 3-2

Phenomenon *B* occurred when a bank of 6.9 kv., 1.5-kv-a. distribution transformers was connected in alone. A different phenomenon (*D*) occurred when the 5.96-kv. tap on this bank was used (this tap of course would not be used in practise on a 7.2-kv. circuit). Phenomenon *D* consisted of an oscillation at triple frequency of the neutral (or ground) outside of the delta-voltage triangle; equal or balanced voltages of about 3.5 times normal appear on the three transformers; audible "buzzing" and excessive corona occur. Phenomenon *D* did not hold long enough at any time to obtain a complete set of instrument readings; evidently *D* is easier to prevent than *B*.

SIGNIFICANCE OF RESULTS

Phenomena *A*, *B*, and *C* and the conditions under which they occur are not characteristic of any particular ungrounded system or type of transformer. As phenomena *B* and *C* endanger the potential transformers themselves so the former also endangers other connected equipment. All three phenomena tend to cause incorrect synchronizing and incorrect relay operation; the difficulties depend to some extent on the secondary connections used.

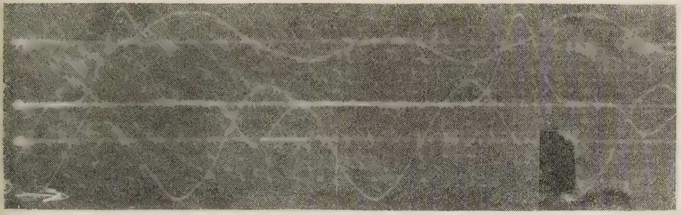


Fig. 6. 7.2-Kv. potential transformers—phenomenon C

Curve *A*, voltage 3-*N*; curve *B*, current line 3′; curve *C*, voltage 1-3

Y-Connected Secondaries. Ordinarily, if any one of the *L*/*N* voltages should be chosen for synchronizing purposes, it is evident that the indications frequently obtained would be considerably in error both in magnitude and in phase position, to say nothing of wave shape and frequency. This particular difficulty could be overcome readily by using any one of the *L*/*L* voltages; however, the correct effective secondary values would not be indicated by the voltmeters for phenomena *B* or *C*, although this error would be small (see Table II); also, there might be some disturbance caused by throwing together two systems, one of which was being subjected to phenomena *A*, *B* or *C*.

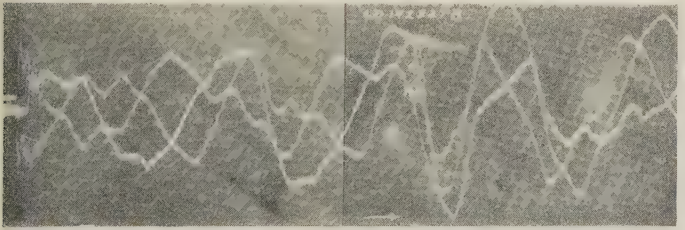


Fig. 7. Six 63.5-Kv. potential transformers (two Y-banks)—start of phenomenon A (and B)

Curve A, voltage 3-*N*; curve B, voltage 2-*N*; curve C, voltage 1-*N*

"Broken-Delta"-Connected Secondaries. Ordinarily, the high-impedance "ground relay" connected across the "broken-delta" would operate frequently, although no accidental ground existed on the system.

These difficulties can be overcome in various ways; such as by grounding the sections of the system, by using the *L*/*L* connection for all potential transformers, by providing protective resistor burdens for *L*/*N*-rated potential transformers or by using potential transformers of considerably higher than *L*/*N*-voltage ratings for the *L*/*N* connection, and thereby lowering the point on the saturation curve at which the transformers normally operate.

GENERAL RECOMMENDATIONS

These recommendations are intended to serve as a guide in the application of grounded-neutral, Y-connected potential transformers to three-phase, three-wire systems or sections thereof, which temporarily or permanently are ungrounded.

TABLE IV
APPROXIMATE RELATIVE VALUES OF PROTECTIVE RESISTOR BURDENS REQUIRED TO PREVENT OCCURRENCE OF PHENOMENA *A*, *B*, AND *C*

	Y-Connected Potential Transformers		
System or Section Neutral	Primary Neutral	Normal Voltage Rating	Relative Value of Burdens
Ungrounded temporarily	Grounded	*L*/*N*	1.0
	Grounded	*L*/*L*	0.5
	Grounded	2 × *L*/*N*	
Ungrounded permanently	Grounded	*L*/*N*	1.5
	Grounded	*L*/*L*	0.75
	Grounded	2 × *L*/*N*	0.25

Protective resistor burdens should be used in practically all cases if the occurrence of phenomena *A*, *B*, and *C* is to be prevented under all possible operating conditions. It is always desirable to keep the volt-ampere ratings of such burdens as small as possible and this involves a consideration of the characteristics of each proposed installation. The magnitude of the burdens provided for the potential transformers of *L*/*N*-voltage design on the 12-kv. and 110-kv. systems was determined experimentally and a rough idea of the general requirements was thereby obtained; the magnitude of these burdens constitutes the standard of reference for the relative values in Table IV.

A differentiation is made in Table IV between temporarily and permanently ungrounded systems. The ratio of the volt-ampere ratings of the protective burdens recommended for the two conditions is about 1 to 1.5. It is believed that a greater margin of safety is desirable for permanently ungrounded systems, since they are always subject to disturbances tending to displace the neutral from its normal position; installations of potential transformers on such systems have not been investigated.

Physical Nature of Neutral Instability

Experience has established the fact that three-phase-system neutrals may become subject to strange phenomena of instability under apparently normal conditions. The authors give facts and explanations based upon extensive experimentation.

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FROM time to time the attention of the Institute has been drawn to some peculiar troubles accompanying the operation of power or potential transformers connected Y-Y with grounded neutral on an otherwise isolated system. (See bibliography) The phenomena under discussion are found only in circuits with capacitance and saturation, and therefore it is proposed to build up the present discussion starting with an analysis of the characteristics of iron-core reactors in combination with capacitors.

Iron-Core Reactor Shunted by a Capacitor. When the volt-ampere characteristics of a saturating inductance (such as the magnetizing current of a transformer) and of the shunt capacitance are plotted, the resultant characteristic curve of the combination is as shown by the curve of Fig. 1. It is realized that the exciting current of a transformer is much more complicated than that of a capacitor. While the latter may be considered as yielding a pure leading current, the former always will contain a lagging component, a power component, and harmonics. Since the lagging component frequently is 80 or 90 per cent of the total exciting current, its behavior in the network is of importance.

Negative or Leading Reactance Zone O-A (Fig. 1). In this zone I_o is leading and the combination behaves like a negative, or capacitative, reactance. As the graph is substantially straight the circuit parameter (the equivalent reactance of the combination) is constant, and like any linear impedance the behavior of the outfit in a network in combination with other impedances is stable.

Unstable Zone A-B (Fig. 1). In this zone the resultant current I_o still is leading, but instead of increasing with increasing voltage it diminishes. Consequently while the gross apparent reactance still is negative, leading, or capacitative, the differential or incremental reactance (the reactance for increases or reductions in current) is positive, lagging, or inductive. Thus,

$$X \text{ considered as } \frac{E}{I} \text{ is negative, leading, capacitative,}$$

and

$$X \text{ considered as } \frac{\Delta E}{\Delta I} \text{ is positive, lagging, inductive.}$$

Such a characteristic *under suitable network conditions* may become a source of instability somewhat analogous to the case of an arc.

Positive or Lagging Reactance Zone B-D (Fig. 1.) In this zone the current is lagging and increases with the voltage (even though not in exactly direct ratio). Thus both the gross and the incremental reactance of the combination are lagging or inductive, therefore the behavior of the combination is approximately that of a plain saturating inductive reactance. An equilibrium point in this zone tends to be stable.

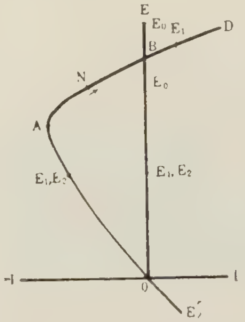

Fig. 1. (Left) Resultant volt-ampere curve of an iron-core reactor with capacitor in parallel

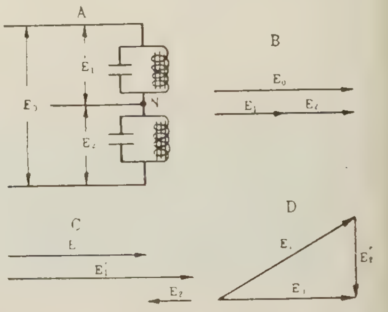

Fig. 2. (Right) Inversion in a single-phase circuit

(A) Single-phase circuit with unstable neutral
(B) Vector diagram for normal neutral condition
(C) Vector diagram for inverted neutral
(D) Same as (C) with prominent quadrature component

A Multiple-Valued Function. Aside from the change in the value and algebraic sign of the resultant reactance from zone to zone of the characteristic curve, another interesting feature to observe is the double-valued character of the curve. Over a wide range, including *O-A, A-B* and part of *B-D*, and the corresponding zones below the horizontal axis, there are to any given value of current, two totally different possible values of voltage.

Resonance and Natural Frequency. At point *B* (Fig. 1), where the resultant current I_o is zero, there is parallel resonance at impressed frequency, that is, the outfit has a natural frequency of oscillation equal to that of the impressed voltage. In such circuits currents undoubtedly are distorted, but that does not invalidate conceptions of resonance and free oscillations.

Classification of Abnormal Phenomena. In analyzing the various abnormal phenomena it is found that

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From "Physical Nature of Neutral Stability," (**No. 31-186**) presented at the A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

they fall into two distinctive groups—(1) those which involve merely a shifting or inversion of the neutral and are primarily phenomena of fundamental impressed frequency; and (2) those which do not disturb the fundamental frequency voltages, but introduces an oscillation into the neutral, higher or lower than the impressed frequency.

I—INVERSION OF NEUTRAL

Inversion in a Single-phase Circuit. Referring to Fig. 2A, let branches 1 and 2 be duplicates; a point of equilibrium for N obviously is half-way between the potentials of the terminals, as shown in Fig. 1 and also by the vector diagram of Fig. 2B: where

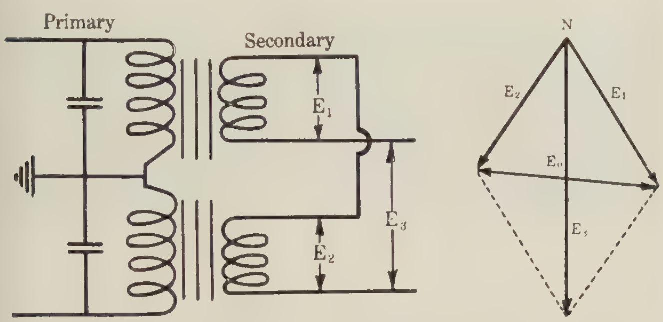

Fig. 3. (Left) Circuit for single-phase neutral instability tests, and (Right) vector diagram showing neutral shift

$$E_1 = E_2 = E_0/2,$$

where E_0 is the line voltage, and E_1 and E_2 are the branch voltages. If the branch voltages E_1 and E_2 are within the zone O-A (as shown in Fig. 1), the potential of N once so established (Fig. 2B) will be normal and stable. The line current will be leading, both branches acting capacitatively. Assume, however, that when the line switch is closed, the starting transient unbalances the voltages and carries one of the branch voltages, say E_1, into zone A-D; a new and abnormal condition of equilibrium may now become established as follows:

Considering the characteristic curve (Fig. 1), it is seen that not only

$$E_1 + E_2 = E_0,$$

but also,

$$E_1' + E_2' = E_0.$$

In the latter case, E_2' is negative, E_1' is greater than the line voltage (see also the vector diagram of Fig. 2C), and the neutral potential is outside of the line voltage. Obviously, one leg or branch of the circuit is acting inductively; the other, capacitatively.

With a different line voltage say E_0'' (Fig. 1)—a still different type of abnormal equilibrium may take place with the leg or branch voltages assuming the values E_1 and E_2 respectively, in which case then, both branches are operating capacitatively, one overexcited, the other underexcited. A still different position of the neutral may correspond to one leg operating in the zone A-B, the other in the zone B-D, both legs overexcited. Such a case was observed in single-phase tests.

Inversion in a Three-Phase Circuit. If the neutral of a Y-Y or Y-broken-delta bank of transformers is grounded on a circuit which otherwise is isolated, the neutral of the transformers is joined to the neutral of the line capacitance to ground, resulting in an equivalent circuit such as shown in Fig. 5. Each leg of this network will have a volt-ampere characteristic similar to Fig. 1, capable of acting either as a capacitative reactance or as an inductive reactance.

Assuming the three legs to be duplicates, the normal position of the neutral will be at the center of gravity of the line voltage triangle. However, other positions of equilibrium also exist, for instance, two of the legs operating in the zone B-D with a lagging power factor, and the third in the zone O-A with a leading power factor, as explained for the single-phase circuit, in which case one leg will be reversed and the other two will be greatly overexcited; the neutral will fall outside of the triangle of line voltages. The alternative case, in which all the legs operate capacitatively, one in the zone O-A, the other two in the zone A-B, as discussed in connection with single-phase neutral shift (the neutral falling just inside the line voltages) also has been observed. (See companion paper by C. T. Weller.)

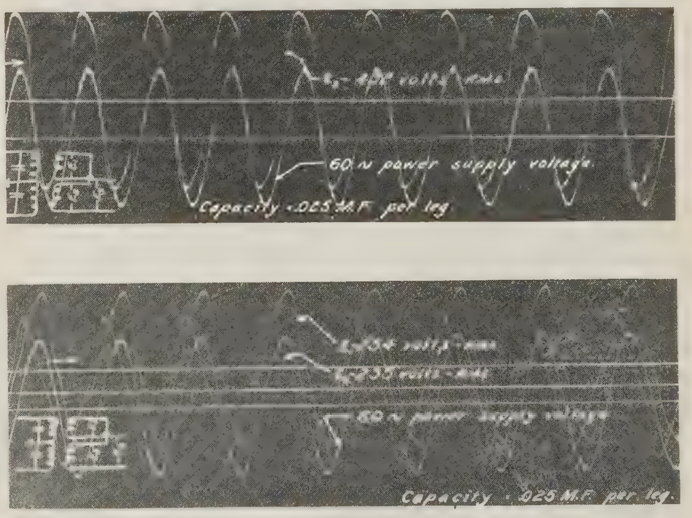

Fig. 4. Oscillograms showing neutral shift in circuit of Fig. 3

Since any one of the legs may become underexcited, depending upon the instant of switching, there will be at least three abnormal stable positions of the neutral.

SINGLE-PHASE INVERSION TESTS

Two duplicate standard potential transformers, rated 13,200/100 volts, were connected in series to yield a neutral point as shown in Fig. 3, and each transformer was shunted by a variable capacitance the settings of which were made alike in all cases. When the circuit voltage was brought up gradually the neutral was found to be normal in all cases. However, when the voltage to the circuit was applied suddenly, inversion of the neutral point was observed over a fairly wide range of capacitances, this range depending on the excitation of the transformers. The secondaries (low-voltage) of the potential transformers may be seen connected in series-opposition to segregate the abnormal voltage component of the neutral. Obviously, with balanced branch voltages the terminal voltage of the secondaries as connected would be zero, but if the neutral should shift, invert, or oscillate, the phenomenon will appear in the resultant voltage of the two secondaries in its pure form, unmixed with normal voltage.

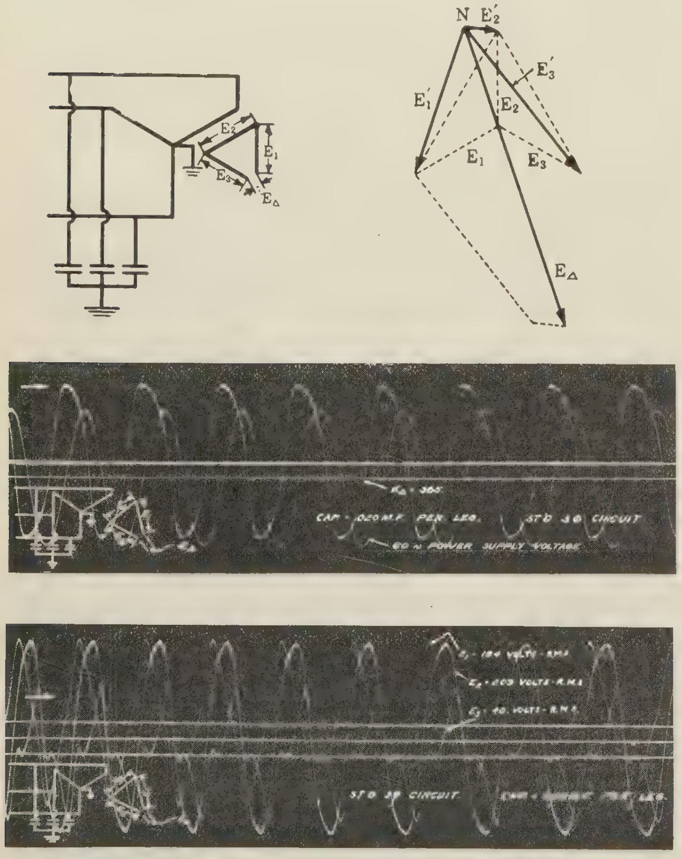

Fig. 5. Circuit and test results for three-phase-neutral instability

With line voltages representing from 100 to 120 per cent excitation on the potential transformers the neutral of this single-phase bank frequently would come in inverted, with capacitances of from 0.025 to 0.050 mfd. across each unit (on the high voltage side). With line voltage representing 120 per cent excitation, a typical set of readings gave $E_1 = 193\%$, $E_2 = 178\%$, and $E_3 = 328\%$ of the values corresponding to normal neutral.

The oscillogram of Fig. 4 shows that all voltages are of fundamental frequency and reasonably good wave shape. The vector diagram of Fig. 3 shows the branch voltages to be of the same order of magnitude, and the neutral to have shifted almost in quadrature with the impressed voltage. The significance of this is that one of the branches is operating capacitatively in the zone *A-B* (Fig. 1) fairly close to *B*, the other inductively in the zone *B-D*, but again fairly close to *B*. Only such a combination will give an inversion in which E_1 and E_2 will be so nearly equal.

THREE-PHASE INVERSION TESTS

The circuit is shown in Fig. 5; it should be observed that when the neutral is normal the voltage across the corner of the delta will be zero; but when the neutral moves from this position it will show in the corner of the delta. Thus, only those phenomena which disturb the neutral can appear across the corner of the delta; all others cancel out. Voltage oscillograms taken at this point therefore show clearly the nature of the disturbance of the neutral. The magnitude of this voltage will be three times the corresponding component in each leg. The vector diagram of a typical case of inversion is shown in Fig. 5.

The oscillograms of Fig. 5 give evidence that the phenomena are of fundamental frequency and of reasonably good wave shape. The data show that two legs are overexcited (acting inductively) and one underexcited (acting capacitatively). The fact that the neutral shift is not exactly parallel to the normal leg voltage of the underexcited leg is due largely to the losses.

It was observed that upon switching in, any one of the three legs might come in reversed.

II. OSCILLATING NEUTRAL

Oscillations at half, double, and triple frequencies, with low-frequency beats and high-frequency harmonics also have been observed.

In Fig. 7 is illustrated a single-phase case in which the oscillation persisted indefinitely. Note the purity of the wave shape and that it is exactly one-half of the impressed frequency. In examining the waves of the leg voltages (E_1 and E_2) nothing else of importance is found other than a fundamental and a half-frequency harmonic.

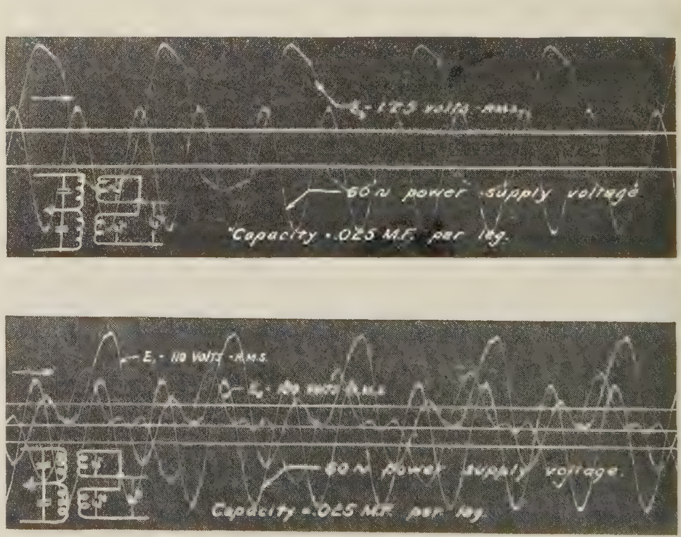

Fig. 6. Oscillograms of oscillating single-phase neutral

In Fig. 8 is given the timing wave (supply voltage), leg voltage and the neutral voltage for a typical case of oscillation in a three-phase circuit. The neutral voltage is observed across the corner of the delta. The characters of these waves may be seen to be substantially the same as in the single-phase tests.

The explanation of the persistance of such oscillations is as follows:

It is commonly known that a Y-open-delta transformer can be used to derive triple-frequency single-phase power from a fundamental-frequency three-phase source. For instance, at nominal 60-cycle densities around 170 kilolines per sq. in., third-harmonic outputs as high as 100 kw. per 1,000 lb. of core can be obtained. This flow of power must be reversible, that is, if the harmonic current is reversed, power must flow from the harmonic to the fundamental.

The free oscillation naturally will be distorted and have higher harmonics. If the impressed frequency is identical with one of these harmonics, power can flow from it to the oscillation as from a higher harmonic to its fundamental, to take care of its watt losses.

A harmonic can deliver to the oscillation not only a certain amount of watts, but also a certain amount of reactive volt-amperes. This is most significant because it makes persistence of oscillations possible without exact resonance. For instance, if the supply frequency is 60 cycles and the natural frequency of oscillation of the circuit is 21 cycles the circuit may oscillate at one-third frequency or 20 cycles just as readily. The difference between oscillating a little off-resonance (20 cycles) and at exactly free resonance (21 cycles) is that the latter requires watts for its maintenance, while the former requires both watts and reactive volt-amperes.

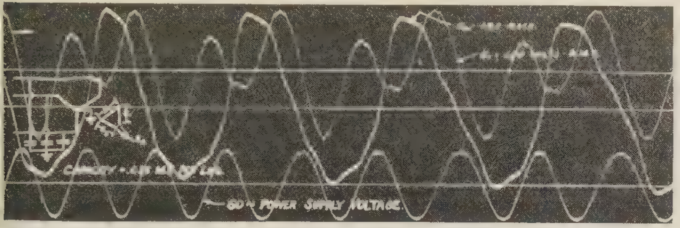

Fig. 7. Oscillogram of oscillating three-phase neutral

Thus, within the extent of the ability of the oscillation to draw watts through one of its harmonics, a free oscillation can be maintained with higher and higher losses; while, within the ability of the oscillation to draw reactive volt-amperes through one of its harmonics, a free oscillation can be maintained farther and farther off from the true natural frequency of the circuit.

CONCLUSIONS

1. Operation of potential transformers in Y-Y with neutral grounded on an otherwise isolated system, (whether permanently or occasionally isolated system, or section of a system), is a somewhat questionable practise unless protective measures are used.

2. Aside from possible trouble due to third-harmonic-voltage intensification, which is so well-known, it is found that with favorable capacitance values from line to ground, natural oscillations are possible around one-half normal frequency as well as double normal frequency.

3. Aside from oscillations, there is the possibility of the inversion of the neutral being unsafe for equipment.

4. Explanation of the neutral shift or inversion is based upon the fact that the combination of a saturable inductance and a constant capacitance has a multi-valued characteristic curve, with leading and lagging zones. For instance, if one leg operates in a leading zone and the other two in a lagging zone, the potential of the neutral is thrown outside of the triangle of line voltages.

5. Persistence of oscillations is accounted for as follows: The frequency of the free oscillation of the circuit must approximate harmonic relationship to the impressed frequency. When the oscillation is at a frequency higher than the impressed, the active and reactive energy flow to it is similar to that from fundamental to higher harmonics, as in static frequency multipliers. When the oscillation frequency is lower, such as one-half of the impressed frequency, the impressed frequency stands in the relationship of a higher harmonic of the oscillatory frequency and the energy flow is reversed because the location of power and load are interchanged.

6. In potential transformer banks intended exclusively for relaying purposes the secondary (or a tertiary) could be connected in delta, and closed through a resistance just high enough to protect the bank from burnout in times of line-to-neutral short circuits; then troubles due either to inversion or oscillation would be entirely eliminated. However, if the bank is to be used for metering as well as for relaying, the currents circulating in the delta due to unbalanced line-to-neutral conditions in the system may affect adversely the metering accuracy of the outfit.

7. Loading the potential transformer from line to neutral also tends to stabilize the neutral and prevent inversion and oscillations. However, this will be a constant load at impressed frequency. It is believed that such a load should be *at least* of the same order of magnitude as the magnetizing volt-amperes of the transformers at normal operating voltage.

8. Operation of potential transformers approximately at half rated voltage is found to reduce greatly the chances of self-excited oscillations. The damping load of the order of the magnetizing volt-amperes at such low excitations is small and well worth-while. Low-density operation and protective load are desirable also from the standpoint of third-harmonic phenomena.

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Progress in Fuel Utilization

IN discussing progress in development and application of boilers and furnaces a recent report of the Fuels Division, The American Society of Mechanical Engineers, says in part:

"The trend toward higher steam pressures and temperatures continues not only in public utility plants but also in industrial plants. Boiler manufacturers are in position to erect commercial units supplying steam up to 1800 lb. per sq. in. and 850 deg. fahr. total temperature. A boiler of the series type suitable for delivering steam at 3,500 lb. pressure is being completed by the Babcock & Wilcox Company and is to be given to Purdue University for experimental work. An experimental and special form of superheater installed at the Detroit Edison Company has operated successfully for some time, delivering steam at practically 1,200 deg. fahr.

"The many novel ideas in boiler-furnace design which have been incorporated in the past few years have received exhaustive tests in commercial operation and the wealth of combustion data thus accumulated has served to eliminate unnecessary refinements. Early enthusiasm over the performance of furnace water walls has been somewhat tempered, and an economical limit for their use has been found in moderate- and small-sized boilers operating under certain restricted conditions.

"Considerable improvement in combustion conditions with stoker-fired boilers has been attained by means of judiciously proportioned water-cooled protecting walls and arches. Simultaneously the air-cooled and sectionally supported refractory walls have amply justified expectations in many cases. Notable progress has been made in the rate of firing per boiler unit. The record-breaking performance of the new boilers at the East River station of the New York Edison Company is due mostly to the excellent functioning of the fin-tube furnace of 39,000-cu. ft. volume, where up to 75 tons of powdered coal have been burned per hour."

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Theory of Abnormal Voltages

Abnormal line-to-neutral transformer voltages may be said to be self-excited by successive alternate saturations and limited in magnitude and frequency by multiple saturations. Outline of theory is given here.

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Associate A. I. E. E.

ABNORMAL voltages considered in this paper arise incident to the occurrence of a large harmonic of fractional, even, or odd frequency in the line-to-neutral voltages of certain Y-connected transformer circuits. These phenomena have been described before (see Bibliography) and additional data concerning them are available in the two companion papers reviewed elsewhere in this issue,—one by C. T. Weller and one by A. Boyajian and O. P. McCarty.

ABNORMAL VOLTAGES

The circuit in which the phenomena occur is represented by Fig. 1A or Fig. 1B. The abnormal harmonic is a zero-phase-sequence component existing in the transformer or line-to-neutral voltages. The frequency of this harmonic and, to a lesser extent, its magnitude, are of special interest. In the transient state occurring soon after the circuit is connected to the source the harmonic voltage may be so highly irregular as not to possess a definite frequency. However, after the voltages continue for a while they either disappear altogether or settle down to a fairly constant frequency and magnitude. In these sustained conditions the frequency of the predominant harmonic has been observed to be either one-half of, equal to, double, or triple, the supply-voltage frequency; the problem is clarified, however, if it is realized at once that these frequencies are only special cases of the irregular transients. For the latter, all frequencies are possible (within wide limits), whereas in the former only four are found to occur.

In this abstract the fundamental origin of all of the abnormal voltages is explained. The conditions surrounding the occurrence of sustained voltages are discussed in detail in the complete paper.

The fundamental explanation of the abnormal voltages just described is quite simple; the explanation is handicapped, however, by the complexity of the representative circuits of Fig. 1. An analysis of these circuits must involve the three line-to-neutral or transformer voltages, and the three transformer and three capacitor currents. Add to this a 5,000:1 variation in the open-circuit inductance of each transformer and the problem becomes even more formidable. Obviously the procedure must be simplified. In this paper the simplification has been accomplished by the adoption of an equivalent circuit.

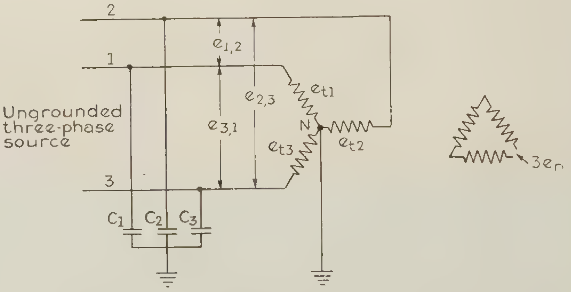

Fig. 1A. Representative circuit

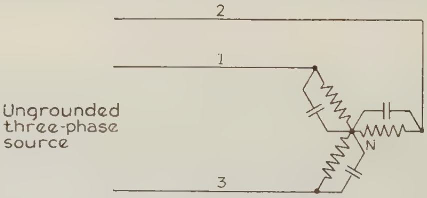

Fig. 1B. Simplified representative circuit

Although Fig. 1A represents the circuits in which the phenomena have been observed to occur, the equivalent circuit of Fig. 2A may be expected to produce the same tranformer voltages and is identical in that respect to Fig. 1A under certain conditions. In Fig. 2A the capacitor voltage is equivalent to the neutral or harmonic voltage and may be visualized directly without the necessity of separating it from the transformer

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From "Theory of Abnormal Line-to-Neutral Transformer Voltages," (**No. 30-184**) presented at A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

voltage as is the case in Fig. 1A. It is the variation in the voltage across this capacitor which introduces the harmonics in the transformer voltages; furthermore, in Fig. 2A the capacitor or neutral voltage is the only voltage that must be determined. The three transformer voltages may be obtained by simply adding the capacitor or neutral voltage to each of the known supply voltages.

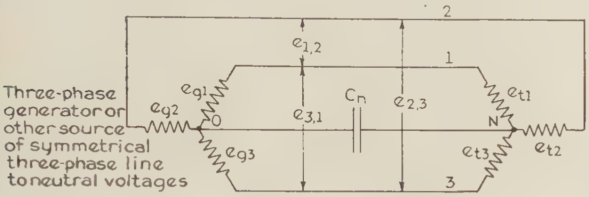
Three-phase generator or other source of symmetrical three-phase line to neutral voltages
2
$e_{1,2}$
1
e_{g1}
e_{g2}
O
$e_{3,1}$
C_n
$e_{2,3}$
N
e_{t1}
e_{t2}
e_{t3}
e_{g3}
3

Fig. 2A. Equivalent circuit

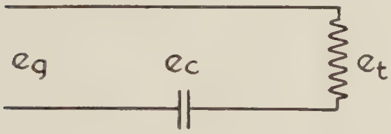

Fig. 2B. Single-phase circuit

Thus by adopting a particular type of supply it is possible to reduce the problem to a consideration of the voltage across a single capacitor. While it is theoretically immaterial which figure is used in the following discussion, the processes to be described will have far greater practical significance if they are based upon Fig. 2A.

ORIGIN OF ABNORMAL VOLTAGES

Saturation during the first cycle after connecting a transformer to a source of voltage is of common occurrence. Such saturations are the result of initial conditions of voltage and residual core densities. In transformers connected directly across a single-phase supply, the initial saturation results in the familiar starting currents represented by Fig. 3. This curve actually consists of a succession of saturations, all in the same direction. Magnitude of the peaks gradually diminishes until normal densities are not exceeded. Each saturation is an individual event consisting of a rise of the current and flux along the hysteresis loop of Fig. 4 and their subsequent decay to normal values. The large current accompanying a single saturation is unidirectional; it cannot become a large reversed current until after the core density reaches saturation values in the opposite direction.

Referring to Fig. 2A (or Fig. 1A), assume the chance occurrence of a single saturation a short time after the supply switch is closed; the resulting unidirectional current must flow into the system capacitance since the unsaturated transformers will not pass any appreciable part of this current. The current flowing into the capacitance builds up a unidirectional capacitor voltage; this voltage continues to rise until the cycle of saturation is completed, at which time the transformer is restored to normal densities. With all of the transformers at normal densities, their impedances are too high to permit the capacitor to be discharged; consequently, the capacitance voltage will be maintained practically constant for the time being.

This action of a single saturation in the circuit is not unlike that of a valve; it injects a large current into the capacitance and then closes the entrance path to prevent its discharge. The magnitudes of the various changes resulting from a single saturation are dependent to a large extent upon the circuit constants, such as capacitance, normal transformer flux densities, size of core, number of turns, etc. It is not necessary to consider these factors at the outset because the fundamental nature of the phenomena may be explained on the assumption that a sufficiently large capacitance is present, and that saturations do occur.

Voltage changes resulting from the saturating process may be readily visualized with the aid of Fig. 5. The dashed-line curves in this figure may be recognized as the three normal line-to-neutral transformer voltages. Assume the switch to be closed at t_0 and that due to the initial conditions the transformer of phase 2 saturates at time t_1; in accordance with the preceding discussion, the saturation of phase 2 will result in an abrupt rise in the capacitance or neutral voltage. For the purpose of illustration this rise may be assumed as vertical. After the single saturation is completed, the high impedance of the transformers prevents the capacitance from discharging and for the time being the neutral voltage remains constant. However, the voltage which the capacitance has acquired adds to the voltage of phase 1 to result in an abnormally large voltage across its transformer. The large voltage, which in the figure is about twice normal, will saturate transformer No. 1 at about t_2. The second saturation is in the opposite direction to the first and consequently results in a reversal of the neutral voltage.

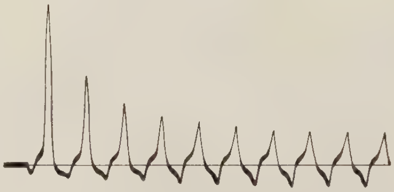

Fig. 3. Transformer starting current

In case it is not clear that the second saturation occurring at t_2 would reverse the capacitor voltage, reference is made to the hysteresis loop of Fig. 4. Once a saturation starts, it will increase in intensity until the transformer voltage reaches zero; so long as there is some voltage, the flux continues to increase. After the flux reaches a maximum, at the instant the transformer voltage reaches zero, it must decline to its residual value. This partial collapse of the magnetic field induces a transformer voltage in the opposite direction. Consequently in Fig. 5, whenever a saturation is assumed to occur, the affected transformer voltage should be reversed by an appreciable amount and the neutral and other voltages determined by subtraction and addition.

The neutral voltage acquired at t_2 remains constant as before, while the transformers operate in the range of normal densities. Again the neutral voltage results in an abnormally large voltage across the transformer of phase 1 and it probably will saturate at t_3 in the opposite direction. This saturation reverses the neutral voltage a third time and the process may be continued for the fourth, fifth, and sixth saturations; and so on indefinitely.

In essentials, Fig. 5 illustrates the origin of the abnormal voltages of this discussion, although the actual wave shapes obtained are not rectilinear. It is evident that the frequency of the voltages is dependent only upon the rate at which the saturations occur and it is not surprising that unusual frequencies have been observed.

At the start when there are wide differences between the core conditions of the three transformers, the saturations occur in a more or less hit-or-miss fashion and the resulting neutral voltages are highly irregular. As the initial differences in core conditions begin to be smoothed out, the time of saturation becomes more and more dependent upon how the neutral voltages combine with the supply voltages. For the voltages to reach a sustained condition it is necessary that some sort of stabilizing process be present which will maintain the voltages within a stable zone. This requirement is satisfied by the formation of multiple saturations or the saturation of two or more transformers in parallel and in the same direction. (Direction of saturation as used here has a very definite meaning when referred to either Fig. 1A or Fig. 2A. Two or more saturations are in the same direction when their respective currents flow in the same direction at the neutral; that is, either out or in.) The proper stabilizing multiple saturations occur only for a limited number of neutral-voltage frequencies,—namely, one-half of, equal to, double, and triple the supply-voltage frequency; consequently these are the only frequencies which can become stable and reach the sustained condition.

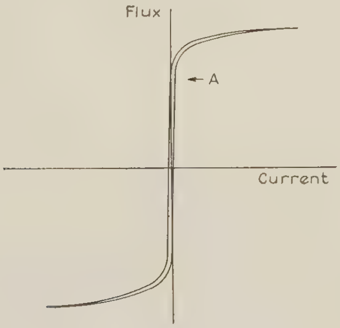

Fig. 4. Hysteresis loop

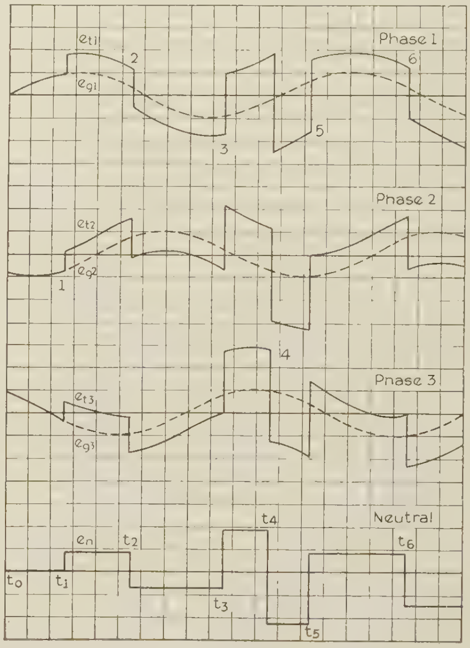

Fig. 5. Hypothetical voltages resulting from an arbitrary succession of saturations ($e_t = e_n + e_g$)

CONCLUSIONS

In accordance with the preceding discussion the abnormal voltages may be said to be self-excited by successive alternate saturations and limited in magnitude and frequency by multiple saturations. The complete theory based upon these two principles explains in an adequate manner the observed characteristics of the phenomena.

BIBLIOGRAPHY

PHENOMENA ACCOMPANYING TRANSMISSION WITH SOME TYPES OF STAR TRANSFORMER CONNECTIONS, by L. N. Robinson, TRANS. A. I. E. E., Vol. XXXIV, 1915, p. 2183. Also Part II of this paper, TRANS. A. I. E. E., Vol. XXXVI, 1917, p. 1081.

INSTABILITY IN TRANSFORMER BANKS, by K. E. Gould, TRANS. A. I. E. E., Vol. XLVI, 1927, p. 676.

HARMONICS OF DOUBLE AND FRACTIONAL FREQUENCY IN THREE-PHASE NETWORKS WITH STAR-STAR-CONNECTED TRANSFORMERS AND GROUNDED NEUTRAL, *Archiv. fur Electrotech.*, Vol. 22, 1929, p. 588.

EXPERIENCES WITH GROUNDED-NEUTRAL Y-CONNECTED POTENTIAL TRANSFORMERS ON UNGROUNDED SYSTEMS, by C. T. Weller, A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

PHYSICAL NATURE OF NEUTRAL INSTABILITY, by A. Boyajian and O. P. McCarty, A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.

Graphical Construction of Hyperbolic Functions

By W. F. Helwig

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Texas Technological College

TRANSMISSION line calculations requiring the use of complex hyperbolic functions are materially simplified through the construction and use of a chart from which both the complex hyperbolic sine and cosine values may be determined in either polar or complex-number form. The device is a polar rectangular chart combined with a specially constructed scale graduated in values of $\frac{\epsilon^a}{2}$ and $\frac{\epsilon^{-a}}{2}$. The chart should be constructed with angles in circular radians and degrees which may be divided into convenient values. In constructing such a chart for practical use it may be convenient to employ heavy lines to denote each interval of 5 deg. and to subdivide these into degrees by fine lines. Ordinary cross-section paper having ten lines per inch is suitable for the rectangular chart.

Theory underlying the construction of the chart is given in the mathematical expressions:

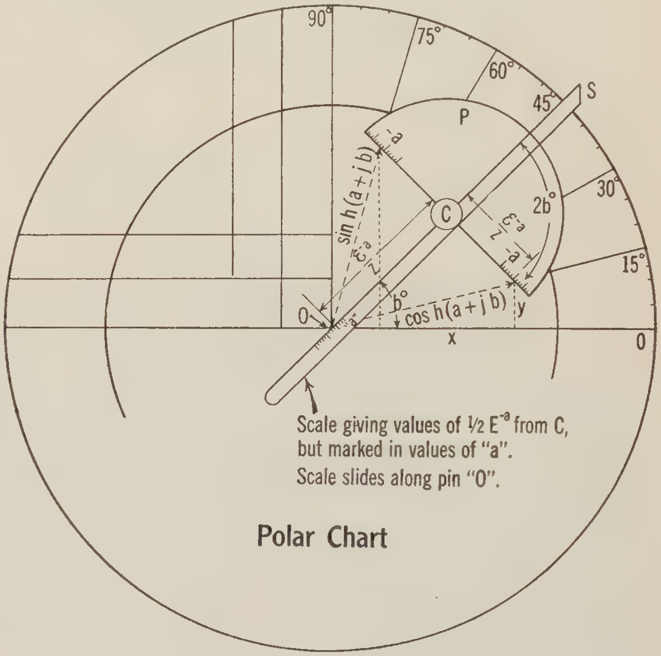
$$\begin{aligned}\cosh(a + j\,b) &= \frac{1}{2}\left[\epsilon^{(a+jb)} + \epsilon^{-(a+jb)}\right]\\ &= \frac{\epsilon^a\,\epsilon^{jb}}{2} + \frac{\epsilon^{-a}\,\epsilon^{-jb}}{2}\\ &= \frac{\epsilon^a}{2}(\cos b + j\sin b)\\ &\quad + \frac{\epsilon^{-a}}{2}(\cos b - j\sin b)\\ &= \dot{V}_1 + \dot{V}_2 \qquad \text{(plane vectors)}\end{aligned}$$

$$\text{Similarly } \sinh(a + j\,b) = \dot{V}_1 - \dot{V}_2$$

PROCEDURE

Referring to the accompanying illustration, $O\,C$ is equal to $\frac{\epsilon^a}{2}$ and is laid off at the proper angle b on the circumference of circle S (this is $\pi/4$ or 45 deg. in the example given). Thus $\dot{V}_1$ is laid off in proper direction and magnitude. Next, the protractor, pivoted at the point C to the scale representing vector $\dot{V}_1$, is turned until its scale $\left(\text{graduated to values of } \frac{\epsilon^{-a}}{2}\right)$ lies at the angle $-\,b$ with the horizontal, or at the angle $2\,b$ with vector $\dot{V}_1$ in the clockwise direction. On this scale, at the required value of $-\,a$, the extremity of the resultant vector $\cosh\ (a + j\,b) = \dot{V}_0 = \dot{V}_1 + \dot{V}_2$ is found. It may then be read directly from the chart either in the form $A + j\,B$ or $C\underline{/\theta}$.

Obviously, the complex hyperbolic cosine may be determined from the same setting by taking the point $\frac{\epsilon^{-a}}{2}$ on the opposite end of the graduated scale along the diameter of the protractor. This is equivalent to reversing vector $\dot{V}_2$ as required for the determination of the hyperbolic sine value.


90°
75°
60°
45°
S
P
-a
sin h(a+j b)
C
2b°
30°
$\frac{\epsilon^{-a}}{2}$
$\frac{\epsilon^{a}}{2}$
-a
15°
O
b°
cos h(a+j b)
y
x
0
"a"
Scale giving values of ½ E^-a from C,
but marked in values of "a".
Scale slides along pin "O".
Polar Chart

Polar-rectangular chart which simplifies transmission line calculations

This device is especially convenient in transmission line problems, since it gives both the hyperbolic sine and cosine at one setting, which values may be directly substituted in the equation:

$$\dot{E}_s = E_r\left(\cosh\dot{\theta}\,1 + \frac{\dot{Z}_0}{\dot{Z}_r}\sinh\dot{\theta}\,1\right)$$

EXAMPLE

To test the operation of such a chart assume that it be desired to determine $\cosh\left(a + \frac{\pi}{4}\right)$. To do this, convert b to degrees and set scale S at the value 45 deg. Then move scale S along the pin at O until the proper value of a is opposite the pin. Next, turn protractor P through an angle equal to $2b$ (90 deg.) along S, and on the edge at a read the desired value.

The accuracy of the device depends, of course, upon the size of the chart and scales used. Experience shows that an accuracy of three significant figures may be obtained from a chart having an outside diameter of 20 inches.

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Greater Efficiency for Low-Head Hydro

For heads up to 70 ft. it is predicted that the automatic adjustable-blade feature of the Kaplan propeller-type turbine is capable of producing at least ten per cent more kilowatt-hours.

By George A. Jessop and *C. A. Powell*

Chief Engineer,
S. Morgan Smith Co.
York, Pa.
Member A. I. E. E.

General Engineer,
Westinghouse Elec. & Mfg Co.
East Pittsburgh, Pa.
Member A. I. E. E.

ECONOMY in first costs has stimulated 20 years of effort to secure a higher speed in hydroelectric units; principally because generator costs go down as the speed increases. Until recently an increase in speed has resulted in a reduction of efficiency—particularly at part loads—to a large extent offsetting the advantages of reduced investment. Improvement in generator efficiency with increased speed has only partially offset these reduced turbine efficiencies. Turbine designers now have succeeded in maintaining the maximum or peak efficiency at a given figure over a very wide range of specific speed, and by means of the Kaplan or automatically-adjustable blade runner have improved the part-load efficiency far above that formerly obtained even with slow-speed Francis turbines.

The relationship between specific speed and maximum efficiency is shown in Fig. 1; the specific speed of a runner is the rev. per min. at which a homologous runner will operate under a one-foot head when it is so reduced in size as to develop one horsepower under a one-foot head. Generally speaking, Francis turbines are used up to a specific speed of 110 and the adjustable and fixed-blade propellers for specific speeds above this figure. Fig. 2 shows a comparison between the peak- and part-load efficiency of turbines with specific speeds ranging from 25 to 150. The turbines with specific speeds of 25, 50, 75 and 105 are Francis turbines. Of the two turbines with a specific speed of 150, one is of the fixed-blade and the other of the adjustable-blade axial-flow type. It is interesting to note how the part-load efficiency drops off rapidly as the specific speed is increased—a defect which can be overcome by the use of the adjustable-blade turbine. The notable feature of this latter type is the fact that its efficiency over the entire range of output is high, exceeding even that of the lowest-speed Francis turbine at low loads.

Generator efficiency varies with the load, as shown in Fig. 3 where it may be noted that the efficiency increases with the size of the unit and also with speed. Because of the more marked effect of the windage losses at the higher speeds the part-load efficiency increases less rapidly than the full-load efficiency. Data similar to those given by Figs. 2 and 3 must be combined to obtain the satisfactory performance of the complete unit.

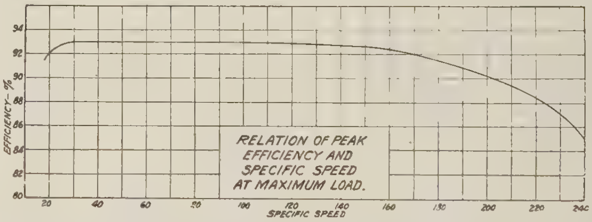

Fig. 1. Relation between specific speed and maximum efficiency

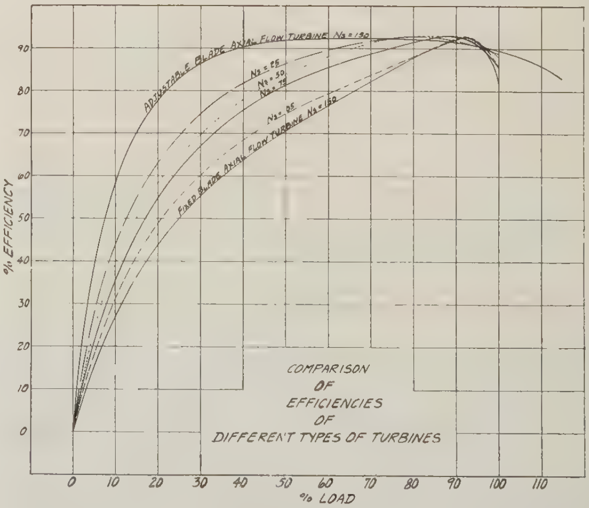

Fig. 2. Turbine load-efficiency curves covering specific speeds ranging from 25 to 150

From "Hydraulic and Electrical Possibilities of High-Speed, Low-Head Developments," presented at the A. I. E. E. Middle Eastern District Meeting, Philadelphia, Oct. 13-15, 1930. (**No. 30-165.**)

In Fig. 4 is made available a graphical method for determining the allowable relationship between head, horsepower, and speed. The head curves represented by full lines are to be used for Francis turbines, and hose represented by dotted lines, for axial flow turbines. At the upper left-hand part of the chart, lines have

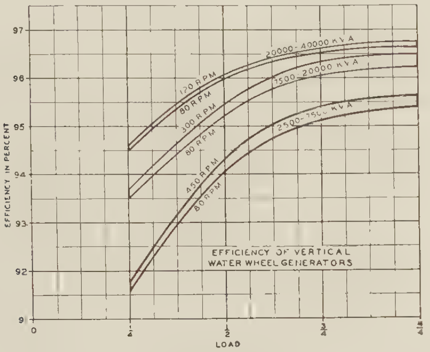

Fig. 3. Generator load-efficiency curves drawn on the basis of normal overspeeds

been drawn indicating approximately the limits of capacity corresponding with the different heads. It s believed that this information will be useful for preiminary engineering work in connection with the designng and estimating of hydroelectric developments and he selection of suitable generator speeds. The limitaions of specific speed set by this chart—that is, the ombination of horsepower, head, and speed—are the esults of many years of experience and at the present tate of the art may be regarded as good practise. If lants are designed within these limits and with the roper relationship between the center line of the unit and tailwater, best results in output, economy, and long life are secured.

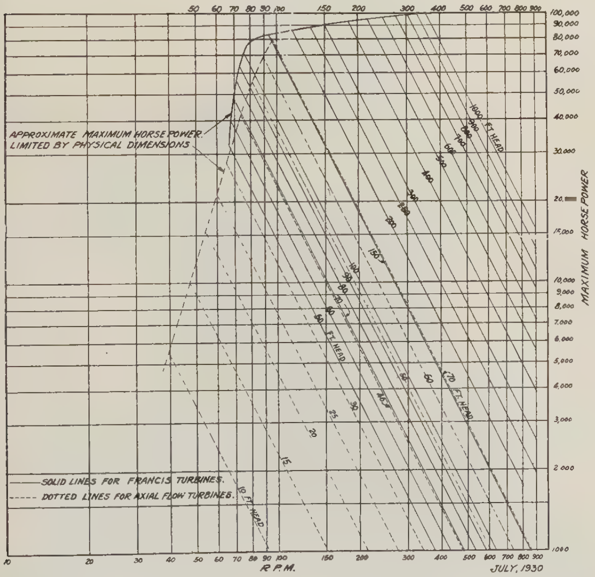

Fig. 4. Chart for graphical determination of allowable relationship between head, horsepower, and speed

The field of application of the fixed- and adjustable-blade axial-flow turbine lies in relatively low head developments,—approximately 70 ft. or less. One of their great advantages is that they permit considerably higher speeds than the older Francis turbine.

Effects of increased speed on the first cost of the turbine are slight, but there is a definite trend toward reduction. The rev. per min. of a fixed-blade axial-flow turbine may be from 70 to 80 per cent higher than that of a medium-speed Francis turbine, but because the amount of water to be handled is the same in either case the reduction in cost will be approximately only 5 or 10 per cent. The small saving effected is incident to handling the water at somewhat higher velocities. From the generator designers' point of view, there is always an advantage in increasing the speed, because the cost of the generator goes down and the efficiency goes up. (Fig. 5)

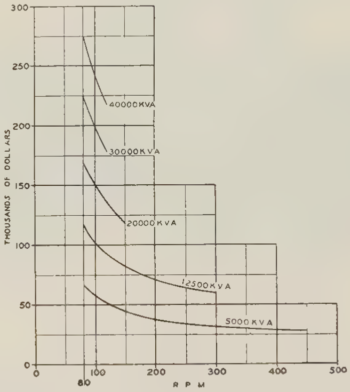

Fig. 5. Generator costs vary with speed and capacity

The cost of an automatically-adjustable turbine is substantially greater than that of a fixed-blade turbine, varying from 20 or 25 per cent for very large sizes to as much as 50 per cent for small sizes. However, this type shows a marked increase in kilowatt-hour output and consequently in earnings; and since the cost of the turbine in most cases is but a small fraction of the whole cost, the total investment is increased only a small percentage.

Excavation and power costs also must be considered in connection with the selection of a turbine. Turbines of high specific speed generally may be set at a lower elevation than those of low specific speed, thus tending to increase excavation cost. This tendency is counterbalanced to some extent by savings in superstructure and it is believed that increased earnings in every case will more than compensate for the greater investment.

As shown in Fig. 6 Kaplan turbine runners resemble a ship's propeller rather than a Francis turbine. Three important Kaplan characteristics are:

1. A vane-free transition space between the discharge area of wicket gates and runner entrance. Water leaving the gates in a whirling inward direction is deflected in this transition space to flow axially through the runner.

2. Wing-shaped runner vanes, so spaced and proportioned that two adjacent vanes form a nozzle or double guidance for part of their radial extent and single guidance for the remainder.

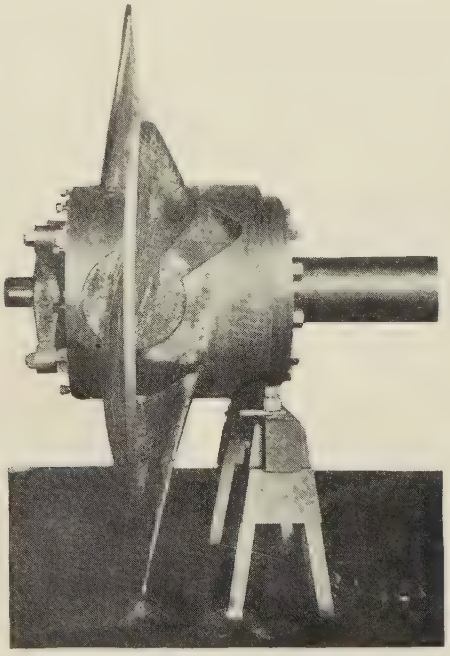

Fig. 6. Axial-flow turbine with adjustable blades open

3. Adjustable runner vanes.

Professor Kaplan was the first to adjust the runner vanes and the wicket gates simultaneously. This maintains the best conditions of flow throughout the entire range of output and results in high part-load efficiencies, thus securing flat efficiency-load curves. Each position of the runner vanes corresponds to a definite position of the wicket gates, and if the efficiency at all rates of discharge is to be maximum the correct relationship of these positions must be maintained. Since the blade and gate angles and openings always have the correct relationship to each other, the adjustable-blade turbine operates with maximum smoothness and with minimum vibration and pitting. Turbine casings are constructed with the usual wicket-gate casing except that the top plate contains an inverted, curved, cone-like projection which forms the inner surface of the transition-space.

All of the operating connections for moving the vanes are contained inside the single-piece hub casting, (Fig. 7), and are of such form that without any adjustment they will stand up indefinitely under the most severe service requirements. To guarantee freedom from excessive strains and to reduce the possible wear to a minimum, stresses are held within conservative limits. To resist wear, bearings for the runner-blade stems and the links are bushed with bronze, and special provision is made to secure the blades against laterial displacement due to the large centrifugal forces developed. To provide constant lubrication for all moving parts, the hub is filled with a heavy-body oil and each runner-vane trunnion is packed to eliminate oil loss.

To synchronize gate control and runner-vane control, each has its own servo motor and distributing valve. The regulating rod in the hollow turbine shaft is moved axially by a servo motor (Fig. 8) arranged between the flanges of the turbine and generator shafts and rigidly connected to them to revolve with the shaft. The servo motor piston is connected directly to the upper end of the regulating rod which communicates the piston movements to the runner vanes. The servo motor is operated by oil supplied under pressure through two pipes arranged concentrically within the hollow generator shaft. The two pipes terminate in two distributing chambers mounted one above the other on top of the generator. These chambers receive the oil from the governor and collectively form the oil supply head. The governor itself is the usual speed governor which operates the wicket gates either through a vertical gate shaft or through servo motors.

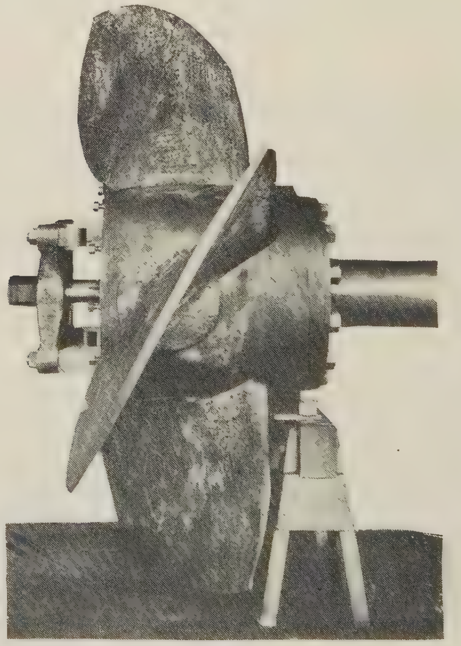

Fig. 7. Axial-flow turbine with adjustable blades closed

The field of application of the umbrella generator is for the large low-head units; and because of its inherent advantages, it is used wherever possible.

To determine the effect of the characteristics of arious types of hydroelectric units on yearly plant utput, a kilowatt-hour output study is given in Fig. 9. or purposes of illustration, a three-unit development as chosen and a comparison made between three edium-speed Francis units, three fixed-blade axial-ow units and three automatically-adjustable-blade xial-flow units, each rated at 28,500 kw. at extreme ll load under a 53-ft. head. The adjustable-blade rbine has a surplus of 15 per cent above the maximum pacity of the other units, and reference to Fig. 2 hows that the adjustable-blade turbine can be selected have this surplus capacity and still have the part-ad efficiency. Even with surplus capacity, the hysical dimensions of the adjustable-blade turbine are naller, and generally speaking, it is possible to operate at a higher speed than a fixed-blade unit. In Fig. 9 may be noted that the adjustable unit is operated at 09.1, the fixed-blade unit at 100, and the medium-eed Francis unit at 58 rev. per min. Generator costs r the adjustable units thus will be somewhat less an for the others.

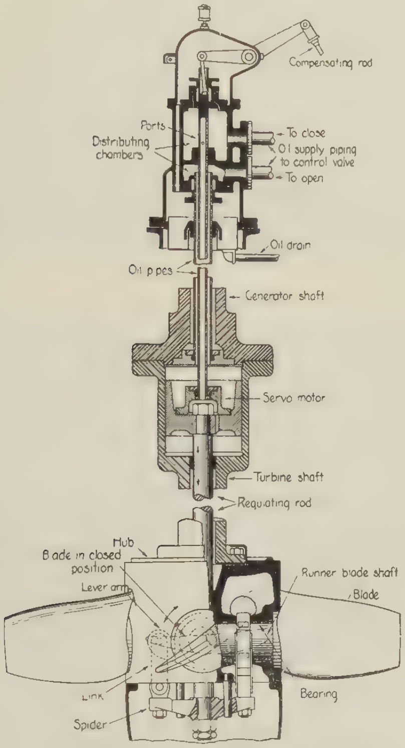

Fig. 8. Assembly and operating scheme of adjustable-blade axial-flow turbine

The kilowatt output was worked up from the head d second-feet available, starting with one unit nning, and changing to more units as soon as additional kilowatts can be obtained by so operating. It s been assumed that if desirable from the standpoint economy in the use of water, each unit can be operated to maximum load and there is no necessity for aintaining a surplus for speed regulation.

It is of particular interest to note that the adjustable units produce 11 per cent more kilowatt-hours than the fixed-blade units and that the Francis and the fixed units have about the same yearly output. If it is necessary to maintain a certain operating reserve, the adjustable units will prove to be even more advantageous than shown, because it will be necessary to operate the Francis and fixed-blade units at even a lower load and consequent lower efficiency for part of the low-flow period. Head and second-foot duration curves are different, of course, for each development and it is necessary to make a special study for each case.

Two types of generators are suitable for use with this turbine; the more general two-bearing design, in which the thrust bearing and one-guide bearing are located above the rotor with the second-guide bearing below the rotor; and the umbrella design in which the single combination thrust-and-guide bearing is located below the rotor. In cost and efficiency there is practically no difference between the two designs, but the umbrella design requires less head room under a crane and is easier to dismantle. Its single bearing runs in a bath of oil, obviating all oil piping, and it lends itself readily to convenient ventilation. If a direct-connected exciter is not used, the upper bracket may be omitted entirely—of advantage in reducing building superstructure.

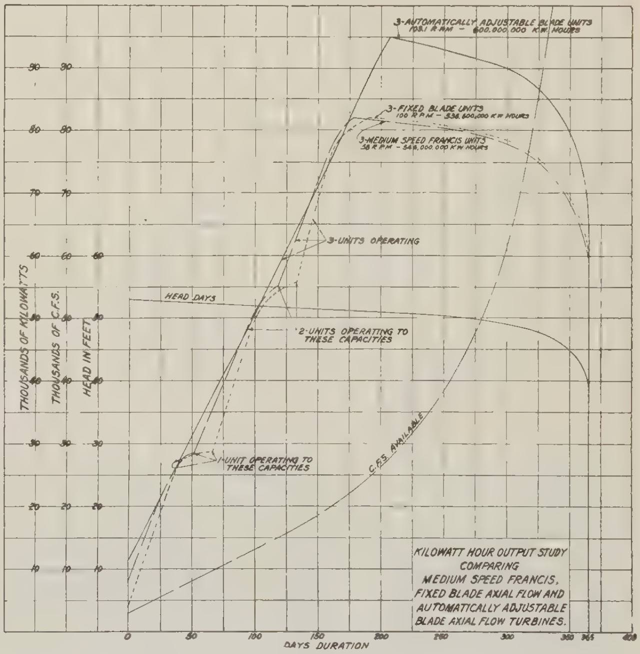

Fig. 9. Output comparison of a three-unit station equipped with three different types of wheels

The field of application of the umbrella generator is for the large low-head units, and because of its inherent advantages, it is used wherever possible.

Detecting Hidden Fissures in Rails

Greater track safety is being accomplished by railroads through the use of a special electrical device which reveals, marks, and classifies dangerous flaws in rails as a test car progresses along the track under test.

By H. C. Drake

Sperry Products, Inc., New York
Associate, A. I. E. E.

"IN THE OLD DAYS" it was not infrequent for flaws in railroad track rails to show up after the wreck. Visual inspections revealed cracks and surface fissures, but hidden fissures—often the most dangerous—remained undetected until the recent perfection of electrical equipment and development of a routine testing technique.

Transverse fissures in rails are fatigue failures of internal origin, whose rate of growth depends largely upon the density of traffic. The typical air-tight fissure has a characteristically bright, silvery appearance produced by the peening action of the fissure faces when the rails are subjected to the impact of heavy wheel loads.

This type of failure was brought to the attention of railway engineers some nineteen years ago when a passenger train was derailed by a rail which broke into seventeen pieces, disclosing a fissure at every fracture. In the years which followed, rail failures due to transverse fissures were reported in ever-increasing numbers. The presence of large transverse fissures in relatively new rails under the best conditions of track maintenance, together with the utter impossibility of seeing or locating such fissures, placed the cause of failure in the class with a cyclone, a lightning stroke, or other "act of God."

In the early part of 1927, internal fissures in rails were successfully detected at the laboratory by the electric method, and after several months of experimental work a fissure-detector car was constructed for the American Railway Engineering Association. The car passed its acceptance test and was placed in testing service on the railroads of the country in November 1928.

For its operation the fissure detector depends upon the fact that electric current flowing through a rail is compelled to pass *around* any fracture, inclusion, or separation in the metal. When a rail is sound the axis of current is substantially straight; but if a fissure is encountered, the current axis at that point is displaced. An inductive pick-up device is mounted directly over the rail head where it cuts the magnetic lines of force surrounding the rail. In the case of a sound rail carrying current, the magnetic flux surrounding the rail is uniform and as the inductive pick-up passes along, no e. m. f. is generated; but when the axis of current is deflected, as at a fissure, the flux density around the rail varies, resulting in a generated potential at the terminals of the pick-up. This output from the pick-up is amplified and led through relays connected to recorder pens, thus giving a record of the impulse received.

In applying the electrical method of fissure detection to inspection of rails in tracking, the following factors materially affect the final design:

1. Many spots are encountered where locomotive drivers have slipped in starting and have gouged out the rail.
2. Worn or flat spots occur frequently, especially opposite rail joints.
3. In certain stretches of track, rail surfaces have acquired a pronounced ripple,—termed corrugated or washboard rail.
4. Frequently the rails are covered with a hard insulating film, the resistance of which may run up to several thousand ohms.
5. The gage of the track varies between certain limits.
6. Rail surfaces may be level or canted.
7. Rail sizes vary from 70 to 130 lb. per yard.

The single-unit type of detector car is 45 ft. long, self-propelled, equipped with extra-heavy frame and axles, and when running to and from work, is capable of a speed of 45 mi. per hour. Just back of the driver's compartment are located the cook's galley and comfortable living quarters for the crew; and back of the living quarters is the compartment containing the power plant of the detector equipment. At the rear of the car is the operating room. The power plant consists of a specially-designed double-commutator, 6,000-ampere, two-volt, d-c. generator direct-connected to a 50-hp. four-cylinder gasoline engine. An exciting generator and an air compressor are driven also by this engine. Current from the two-volt generator is carried by heavy buses to the brush units under either side of the car.

This brush-unit assembly consists of two sets of eight solid phosphor-bronze brushes mounted about three feet apart, rigidly connected by a cast frame, and supplied with individual springs which insure a pressure of 50 lb. per brush. Flanged wheels at the ends of the brush-holder engage the rail when the brushes are down and because of their angular mounting, cling to the gage side regardless of varying track conditions. Brush units are applied to the rail by air-operated pistons electrically controlled from the operator's switchboard. If the driver attempts to back up while they are on the rails, a safety switch connected to the gear shift of the car drive automatically lifts these brushes.

Brush-contact resistance has been found to be greatly reduced by the use of water on the rail; hence provision has been made to carry a sufficient supply of water for this purpose and to apply it automatically to the rail when the brushes are lowered. Mounted

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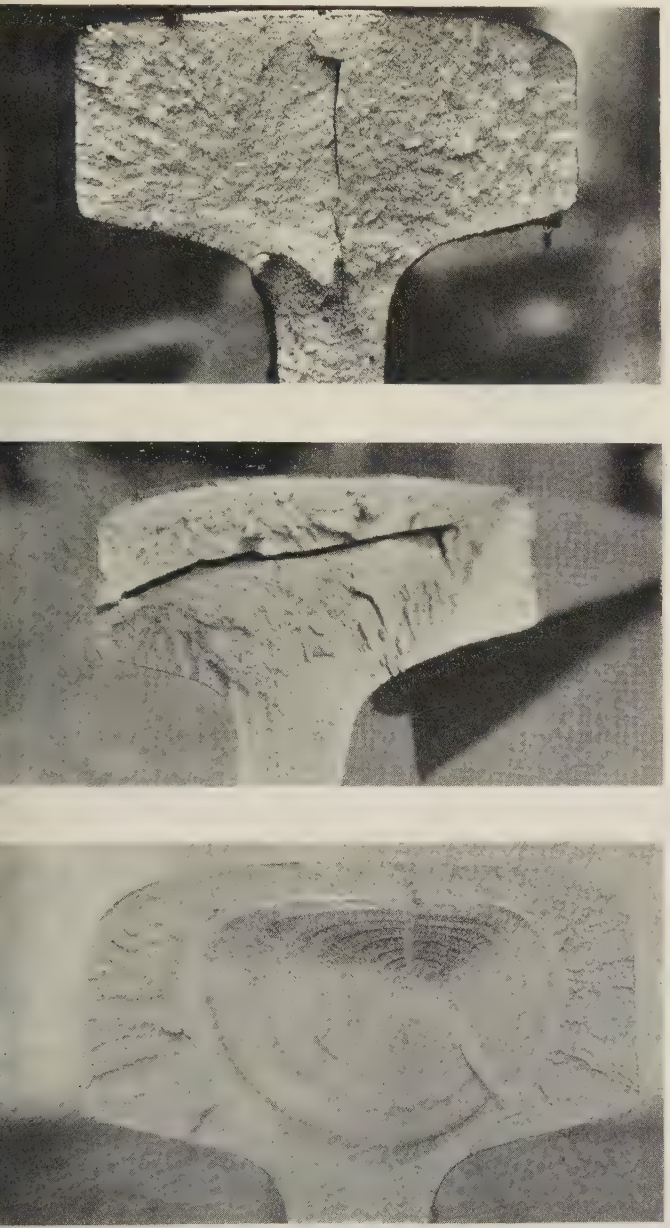
Presented at the Winter Convention, New York, Jan. 26-30, 1931. (No. 31-28)

etween the brushes is a separate carriage upon which supported the pick-up unit; this carriage with its ght wheels and swivel mounting holds the pick-up nit at a fixed distance above the rail, riding over burns nd flat spots without interruption. At first the driver urns and flat spots gave indications which tended to low the testing; but that source of trouble was reduced naterially by the eight-wheel mounting. Recent imrovements in pick-up devices eliminate indications rom flat spots and all but the largest of the burns.



Typical fissures found in railroad track rails; (lower) the internal fissure, (center) a horizontal head fissure, and (upper) a split head. The electrical testing device infallibly locates these under service conditions

The operating room at the rear end of the car conains the recording table and control board as well as mplifying equipment and batteries. The output from the pick-up unit is brought up to a four-tube amplifier which is properly shielded and protected from shock. Three recorder pen relays are connected to the output of the amplifier and adjusted to respond to different values of plate current, thus giving an indication of the size of the defect detected. Other relays are provided to operate paint guns so that the fissure location will be marked automatically by a spot of paint on the rail or tie.

As shown in an accompanying illustration, the record is made up of nine lines, resulting from as many pens, which indicate the relative size of each fissure and the rail in which each is found, the passage of each rail joint, and the passage of each identifying landmark. Joint cut-outs mounted on the brush-holders engage the angle bars and cut out the fissure pens and paint gun at each joint, at the same time operating the joint pens. The landmark pen is operated from the car driver's switchboard. He presses the button whenever a mile post, bridge, signal tower, or other landmark is passed, and the operator at the recording table stamps in the proper designation.

In operation, the car passes along the track at approximately six miles per hour with from 2,000 to 3,000 amperes flowing through each rail, the current value depending upon the weight of rail being tested. The operator seated at the recording table in the rear of the car has before him both the record chart and a clear view of the tested track. When the car passes over a fissure, an indication appears on the record and the defect is marked automatically with a spot of paint. The operator notes the record, sees the paint mark on the rail, stops the car and backs it up to the paint mark for a hand test of the suspected spot. For the hand test a current of 1,500 amperes is induced into the rail by means of air-operated contactors and the unit *I R* drop is measured with a galvanometer. By means of this test the size of a transverse fissure can be determined within a few per cent.

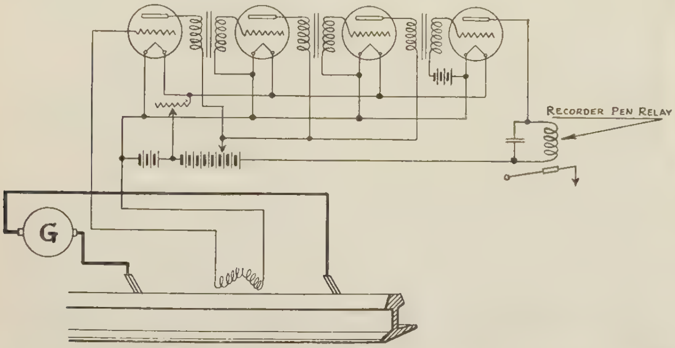
A self-propelled detector car; brush and pick-up units mounted between trucks

The detector car locates not only transverse fissures but split heads, horizontal fissures, compound fissures, pipes, cracked webs, broken bases, and other defects. When a defect is located by the car the first question asked by the railroad representation is, "will it be safe to leave the rail in track until there is a lull in the day's traffic, or must the next train be tied up while the rail is replaced?" The answer to this question lies in the result of the hand test. When the hand test shows no transverse crack the rail is marked for removal at the next opportune time; but if a large transverse fissure is indicated, the railroad takes no chance but removes the rail at once.

Although the testing speed of the car is six miles per hour, there are many elements which enter in to limit the total mileage tested per day:

1. Traffic delays due to clearing for trains frequently consume considerable time, but are unavoidable.

2. When a fissure is located the railroad representatives always makes a record of the manufacturer, the year rolled, ingot letter, and heat number of the rail. If the rail has been in track for several years or has been oiled by the track oiler, it is often difficult to locate and decipher the heat numbers and it is not at all uncommon on some roads to have from five to fifteen minutes wasted in obtaining the rail data.

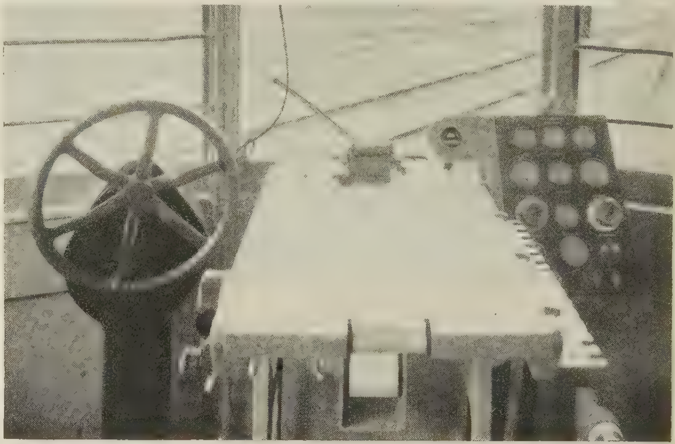


A main bush and pick-up unit; flaws in the rail disturb smoothness of current flow between brush sets, resulting in electromagnetic disturbances which are picked up by the central device and recorded in the car

3. A repeat run over a suspected rail takes thirty seconds, and from two to three minutes are necessary for a hand test.

Testing procedure on the ten cars now in service is practically identical, but railroads differ somewhat in methods of conducting the test. A survey of the various methods employed indicates that the following procedure results in a minimum loss of time.

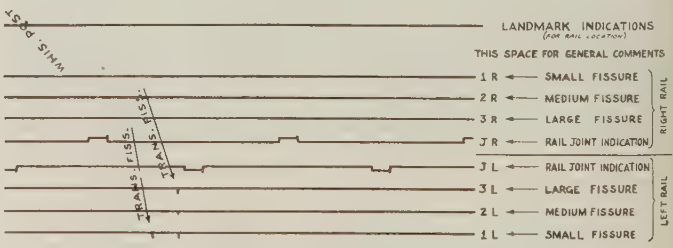
The railroad has one man on the car and one on a hand car which follows the detector car. In addition there is of course a conductor and a flagman. When an indication is recorded the car is stopped, a check run made over the suspected rail, and the car backed up for a hand test. The operator examines the rail and if his visual inspection discloses exterior evidence of a split head, horizontal fissure, or other defect, he gives the word to the railroad man, who makes a red paint mark on the tie at the defective spot and chalks the identification number on the rail. If no visible defect is noted, the hand test is made and the rail is marked as before.



Recording table and control board; the operator can watch the track as well as his instruments

The car then proceeds with the testing while the man on the handcar stops to record all of the data, together with the location of the rail, and then continues on after the test car. In this way the maximum time lost by the major equipment and crew is the two or three minutes required for hand testing.

Two years have passed since the first detector car was placed in service and during that time many interesting fissure facts have been accumulated. A single rail has been found to contain as many as 24 transverse fissures. Fissures have been found in rails 28 years old, and in rails five months old. Many consecutive miles of track have been found to be free of fissures while other short stretches have had from 20 or 30 fissures per mile.



A typical record made by the detector car equipment

While these isolated cases are of interest, the most important point is that the transverse fissures are now being located and removed from track before they can cause damage, whereas prior to two years ago their presence was not even known until they had grown to the surface, or broken the rail.

The Engineer's Duty to Himself and to the Public

The engineer is the one person best qualified to know the vital facts underlying any great project and to interpret their true significance. Upon him, therefore, rests the responsibility of enlightening the general lay public as to the difference between engineering facts and political expediency, particularly where public monies are involved.

By William S. Lee

President, A. I. E. E.

TO DETERMINE the public duty of the engineering profession it is necessary first to understand the engineer's relation to the public. It is an ideal of the Institute that the engineer shall endeavor to assist the public to a fair and correct general understanding of its engineering needs; to ascertain the general knowledge of engineering; and to discourage the appearance of untrue, unfair, or exaggerated statements on engineering subjects in legislation, the press, or elsewhere—especially if these statements may lead to or be made for the purpose of inducing the public to participate in unworthy or unsound enterprises.

When a project of any magnitude is contemplated it is customary to employ engineers familiar with that particular line of work and to submit the problem as a whole to them. After a thorough study of conditions these engineers plan the best layout or design for the project, organize the necessary man power, purchase materials and equipment and ultimately build the project, often organizing the entire operating forces required for its functioning. Thus the engineer is the one person best qualified to know all pertinent details of his project; to evaluate them properly and correctly.

Unfortunately for the public at large, unbiased and fundamental engineering information on major projects seldom is broadcast to the public concerning public or quasi-public projects. In the inevitable financing of any project it is usual that only a few of those involved are well informed. If the project be one in which large numbers of citizens participate in public financing, the engineers' reports seldom if ever penetrate beyond the inner circles, except perhaps in modified form. If the project be one which can be handled with the financial assistance of but a few persons, still only a small group gets a real, direct understanding of the importance of the engineer's position and advice. The result is that great projects are designed, constructed, and put into operation by but few members of the great general public which in the long run pays all the bills.

Consider for a moment those wonderful and enormous projects which you have seen completed by engineering ingenuity in the last two decades. Great organizations and great masses of men and material were mobilized for the purpose by "that army from God knows where."

> "No bands were gaily playing,
>   When they were going into action;
> No crowds were madly cheering
>   Their deeds of daring do.
> They were owing small allegiance
>   To any flag or faction;
> Their color was on the sky-line
>   And their war-cry put it through."

If the engineer is capable of designing, constructing, and operating these projects, he certainly should be taken into the confidence of the public. His assistance should be invaluable in advising the public as to policy in regard to these developments which play such an important part in the growth and well-being of our country.

It is my wish to emphasize the urgent duty of the engineer not only to convince his brother engineer that his design, construction, and operation are right, but to advise the public to the end that it may be adequately and accurately informed; that it may see the fallacies of half-baked political theories, and may avoid developments that would be prejudicial to the public interest. The American Institute of Electrical Engineers always has emphatically insisted that in all his relations the engineer should be guided by the highest principles of honor. It holds that it is the duty of the engineer to satisfy himself to the best of his ability that the enterprises with which he becomes identified are of legitimate character.

We in America are confronted today with a situation that is fraught with danger, because of the fact that the public may, through partial or insufficient knowledge, reach erroneous conclusions and undertake developments (legislative or otherwise) that would result in our government entering business in competition with its citizens and thus embark upon a course disastrous to the best interests both of those directly affected and of the taxpayers of the country in general. That is why I am urging the engineer, who is trained to consider only facts and absolutely true and complete conditions, to

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An address delivered before the opening session of the A. I. E. E. winter convention, New York, Jan. 26, 1931.

use his efforts in giving the public the correct picture. An engineer's experience has led him to realize that nothing ever is as good as it appears on first blush and that nothing ever is quite as bad as it first looks. It is the engineer's lot to study a problem with an unbiased mind; to analyze thoroughly and honestly each particular phase of every situation in order to give his client the proper advice. The present national situation is a challenge to the best ability and professional ethics of the engineer—*each engineer*.

President Hoover is fundamentally opposed to governmental industrial ownership and operation. He set this forth very clearly in his concluding remarks in 1924 when, as Secretary of Commerce, he said:

> We are asked to embrace new social ideas, increase our cost of service, decrease our national efficiency, and thus destroy the fundamentals upon which our nation has become great. This is not progressive, for it is not progress. It is destruction.

Ex-president Coolidge in "Calvin Coolidge Says" on January 6, 1931, said in part as follows:

> For wage earners to benefit in time of general depression it would be necessary to assume that government ownership would prevent fluctuations in the business in which it engages. If it is assumed that payment of wages will go on without work, that is not employment, but relief. Then no one should work.
>
> The government has never shown much aptitude for real business. The Congress will not permit it to be conducted by a competent executive, but constantly intervenes. The most free, progressive, and satisfactory method ever devised for the equitable distribution of property is to permit the people to care for themselves by conducting their own business. They have more wisdom than any government.

There are many problems confronting the people of America with regard to public utilities, and especially those utilities that have to do with the generation and distribution of electricity. It is through the engineers I believe that a true and proper study of these problems should and will be made. If the varying tide of sentiment for political or public ownership in this country is based upon correct economic and business principles, the theory should be developed and proved, rather than hurried into existence by retaliatory legislation, an over-persuasive press, or communities that are rightly or wrongly disgruntled.

I cannot refrain from emphasizing the vital necessity of exercising the utmost caution and care in the consideration of these problems. Public ownership in this country and in others, as it has been developed up to this time, by no means has proved that it deserves the support of the people at large; in some instances there have been apparent momenetary advantages, but, in the long run, experience has demonstrated the futility of the arguments of those who favor political or public ownership.

For instance, it has been argued that through the exercise of government financing electric power plants and distribution systems could be constructed with cheaper money. However, it is a well-known fact that construction projects under government supervision generally cost at least twice as much as contruction projects under private ownership, thus eliminating any advantage from this source.

Again, under political or public ownership and operation those properties concerned usually do not pay taxes and the revenue that might be derived from them is of necessity transferred to other sources of taxation. This is a matter of such great public concern that in some states a well-defined movement is under way looking toward the taxing of municipally owned utility enterprises.

In this great country today we are polluted with too much political engineering, political banking, political railroading, and other similar infections too numerous to mention. I think, one of the most dangerous situations that today confronts the engineering fraternity and the public is the mad rush of certain sections to go into political, state, or municipal ownership.

It is the engineer's duty to the public, in these days when there are so many public or quasi-public operations, to make available his judgment and advice so that the people at large may have the advantage of it in arriving at intelligent conclusions in these matters.

It is necessary in this discussion to consider some concrete case: Take the much discussed Muscle Shoals development; why was it built? Does anyone know? Certainly not as a war measure for its actual construction began after the war was over. The nitrate plant located there had constructed a steam plant of a size capable of operating it. This steam plant was within two or three weeks of completion when the Armistice was declared. Why did the government *the next year* begin the construction of Muscle Shoals? I knew and you knew then just as well as we know fifteen years later that it was an unsound venture.

About 1921 the United States government, through its chief of engineers, notified the various power companies and possible power consumers of the South to investigate Muscle Shoals and see if they would be interested in securing power from it through some mutual arrangement. I made a very complete and detailed investigation of this plant, its costs, amounts of power, and other vital points and in a signed report dated May 18, 1921, covering all these matters (a copy of which was sent to the United States Chief of Engineers) my conclusions were given as follows:

> 1. The amount of power estimated by the designing engineer on this work is not correct, nor can it be developed there for practical use. Power cannot be sold as primary power on the basis of average monthly stream flow. Four months' secondary power has no value at present; therefore, the amount of revenue will be materially less than estimated.
>
> 2. Present use of power in the Southern district does not develop more than a 50 per cent load factor. The navigation problems incident to this development are such that this plant will have to be run at approximately 100-per cent load factor in low-water season or waste the water.

3. Total cost of this development will be $56,500,000. The additional cost over the present expenditures will be approximately $40,500,000. The plant when completed is not worth 30,000,000.

4. Transmission of power to the systems of the Southern Power Company and the Georgia Railway & Power Company cannot be done in competition with power from other sources.

5. Power transmission to the systems of the Alabama Power Company or the Tennessee Power Company on the same basis s proposed by the designing engineer would cost these companies twice what they can develop their own plants and produce t for.

6. There is no present use or need for this development.

7. The permanent work that has been done should be left s it is, the construction plant salvaged, and the completion of his plant not undertaken until there is developed some use of he power which will require from 80-per cent to 100-per cent oad factor.

8. Except for a small amount of power that could be sold o the companies operating near this plant, it would stand idle or years, with no use for the power.

9. The loss in discontinuing this work and waiting until ome use for power can be developed will be small as compared o the loss of investing a large amount of money in the plant nd letting it stand idle for years.

10. There is no way at the present time that the United States government can get anything approaching a reasonable return on this development if completed.

11. None of the power companies could afford to purchase power under conditions proposed by the designing engineer, and six of the eight could not afford to purchase at any price, because hey can develop or procure their power from other sources at a ess price than it will cost to transmit the power from Muscle Shoals to their territory.

My reason for discussing Muscle Shoals is the fact hat it involves two great principles of the deepest significance to the whole country, industrially and politically:

First, should the government go into business? The nore people that work for the government the nearer ve approach socialism. I cannot believe that this country is ready to go into socialism; hence why should ve be pursuing this policy? The greatest factor in the levelopment of America has been American initiative—nd certainly when the government goes out and competes with its citizens in business the great American nitiative will be destroyed. Why should a few members of our government persuade the people to set up competition with its citizens when the citizens actually comprise the government? Why should an organization created by the people be endeavoring to destroy he people?

Second, if business is in politics every detail will be he subject of terrific political harangue and investigation.

A review of some of the estimates of cost for Muscle Shoals is startlingly revealing. The development was stimated in April 1920 to cost $23,800,000—say 5 million. Within less than a year this estimate was hanged to 50 million; now, the plant has been partially completed and the cost is approximately 47 million and about half of the generating and hydraulic equipment for the powerhouse remains to be completed. A private corporation would have built the same plant for less than half that cost.

For any hydroelectric plant to be successful, be it government or private, it must be able to compete by selling power at a cost equal to or less than that produced elsewhere. Muscle Shoals has less than 100,000 hp. in primary power. In fact, for many weeks during the past year this was less than 65,000 hp. Now, if this plant already has cost approximately 47 million dollars and is still incomplete, it is futile to think of its competing on any kind of a business basis against other sources of power. No doubt many will say that there is a considerable block of secondary power; this is true, but to utilize the secondary power a steam plant must be built, with resultant interest, depreciation, taxes, and part-operating expenses to be provided for. After provision is made for these charges incident to keeping such a steam plant in condition for service, the additional cost of fuel and part-operating expenses with a modern steam plant will be so low that secondary power from Muscle Shoals will not be attractive.

Would any private corporation enter into such a venture? An estimate of approximately 50 million dollars and plant not complete, almost fifteen years since the project began, no contracts made!

There is no doubt that Muscle Shoals has been a colossal political and governmental blunder, but I fear that the next decade will see even greater blunders if some of the projects which are under way now, or projected, are constructed. If Muscle Shoals, begun nearly fifteen years ago, is today earning nothing and has no policy, what will occur at Hoover Dam? There is a tremendous development started, and nobody knows where it is going. An enormous project already started from the funds of the taxpayers, but without tangible evidence of any definite policy or effective contracts. It is time that these matters be discussed honestly and more frankly by the engineering fraternity with the public to obviate the continuance of these terriffic blunders.

Right in the Greater New York area is the greatest aggregation of engineers in the world, and yet serious consideration is being given by the state government to the building of the Long Sault plant on the St. Lawrence River. Every engineer knows that the government costs of constructing that plant will be two or more times what private costs would be. Further, we know that it is impossible to transmit the power from the St. Lawrence River and make it available to the City of New York in competition with modern local steam plants. It looks as if the public is being ballyhooed for another Muscle Shoals, only on even a more gigantic scale.

Engineers have contributed largely to the remarkable progress that has taken place in the electrical field during the past four decades. The progress in this field has been responsible in a very large measure for the wonderful development of industry in America during that period. We engineers are proud and grateful that we have been able to have a hand in the remarkable progress which America has made during these years; and we should be deeply concerned that no obstacle be allowed to slow down or handicap the economic development which means so much to the American people, from the well-to-do down to the humblest working man.

Hence I protest against this dangerous tendency of the day, and I say to each and every one of you engineers, it is your duty, and mine, both to ourselves and to the public, to use our best efforts to see that the public is correctly and properly advised, for when so advised their conclusions will be sound. For,—

'Tis a coward that quits to misfortune,
'Tis a knave that changes each day;
'Tis a fool who wins half the battle,
And then throws all his chances away.
There is little in life but labor,
And tomorrow may find that a dream,
Success is the bride of Endeavor,
And Luck but a meteor's gleam.
The time to succeed is when others,
Discouraged, show traces of tire;
The battle is fought on the home stretch,
And won twixt the flag and the wire.

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Control Groups Simplify Operation

Unit arrangement, grouping closely around each hydroelectric generating unit all of its associated electric switching and control equipment, accomplishes important economies as well as providing improved operating flexibility and ease of expansion. Radical departures in practise have been combined with others of more usual characteristics to achieve an attractive combination.

By R. M. Stanley and *E. D. Wood*

Byllesby Engineering &
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Chicago
Fellow, A. I. E. E.

Louisville Gas & Electric
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Louisville, Ky.
Member, A. I. E. E.

ELECTRICAL features constituting the control of the Ohio Falls hydroelectric station of the Louisville Gas & Electric Company represent a distinct advance in the art of utilizing well established principles combined in a unique fashion. Thus an initial installation cost lower than usual has been achieved as well as basic provision for extensions which can be made in a most economical fashion from time to time. The design of the station is particularly unique in the fact that each generating unit is complete in itself; water-wheel, generator, exciter, governor, electrical control, and oil circuit breakers are individual to each generating unit, and all related unit auxiliaries are fed entirely from that unit, with but few exceptions. The four points that are retained in common and which reflect the more usual design are (1) forebay, (2) high-voltage buses, and (3) centralized coordinating control for the station.

Each of these features may of course be recognized as embodying well established principles, but the prominent characteristic of the Ohio Falls station lies in the fact that in it are utilized simultaneously, all of these combined to the best advantage. The design is characteristic of simplicity, practically all conduit and wiring as usually encountered having been completely eliminated.

One of the basic ideas was an electrical control unit corresponding to the hydraulic control unit, situated near each generating unit. This feature has been accomplished by grouping all of the electrical control features and placing them inside a cubicle located just adjacent to the governor. But while this concentration of electric and hydraulic control is particularly desirable as far as installation is concerned, it did not seem to solve the problem of economical operation. Therefore a centralized supervisory control was incorporated, with a single multi-conductor telephone cable between it and each generator control unit. This arrangement happily accomplished centralized supervision and control of all units, at the same time reducing to a minimum the number of wire connections between the central control point and the controlled cubicle.

Because of the lower inspection and maintenance expense, operating as well as fixed costs are reduced. Substitution of the miniature switchboard and low-voltage, multi-conductor, lead-covered control cable for the usual large central control board and 19/22 control cable and iron conduit is principally responsible for this improvement. Further saving was realized in

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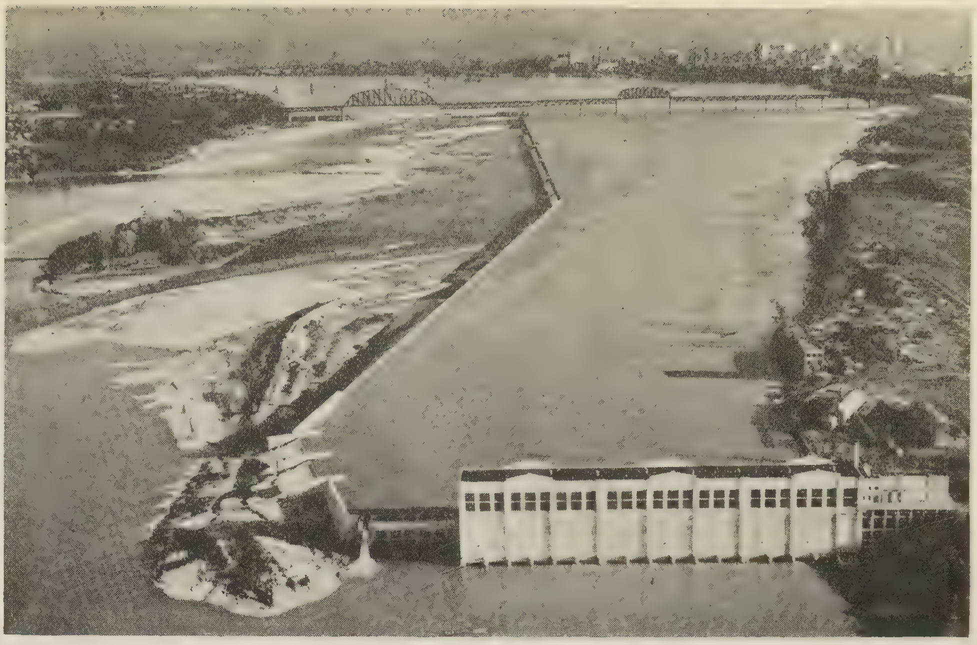
From "The Ohio Falls Hydroelectric Station at Louisville, Ky." (**No. 30-188**) presented at the A. I. E. E. Southern District meeting, Louisville, Ky., Nov. 19-22, 1930.



Ohio Falls hydroelectric plant of the Louisville (Ky.) Gas & Electric Company; City of Louisville in the background. This project was built in cooperation with the U. S. Government in connection with its navigation and flood-control development of the Ohio River

bviating the cost of building, heating, and mainaining a control room of the usual proportions and ocation.

As new 4-, 13.2-, 66-, or 132-kv. feeders and related witching equipment may be required, they can be nstalled in the yard adjacent to the plant and unit-ype switchboards, either singly or in groups, may be laced near the equipment to be controlled. To rovide supervision for the new equipment the miniaure switchboard can be extended four inches at a time o accommodate low-voltage multi-conductor cable nstalled as needed between the miniature board and he unit switchboard at the apparatus; and since the riginal plant layout need not be disturbed, this nay be done at a minimum cost. Another imporant benefit realized in this station is that such exensions and additions do not involve the danger of vork around operating equipment; the hydro station vill not be cluttered with construction tools and debris; nd station operation will not be jeopardized by work eing done on control wiring and conduits located near ctive equipment, as was customary under the old order f things.

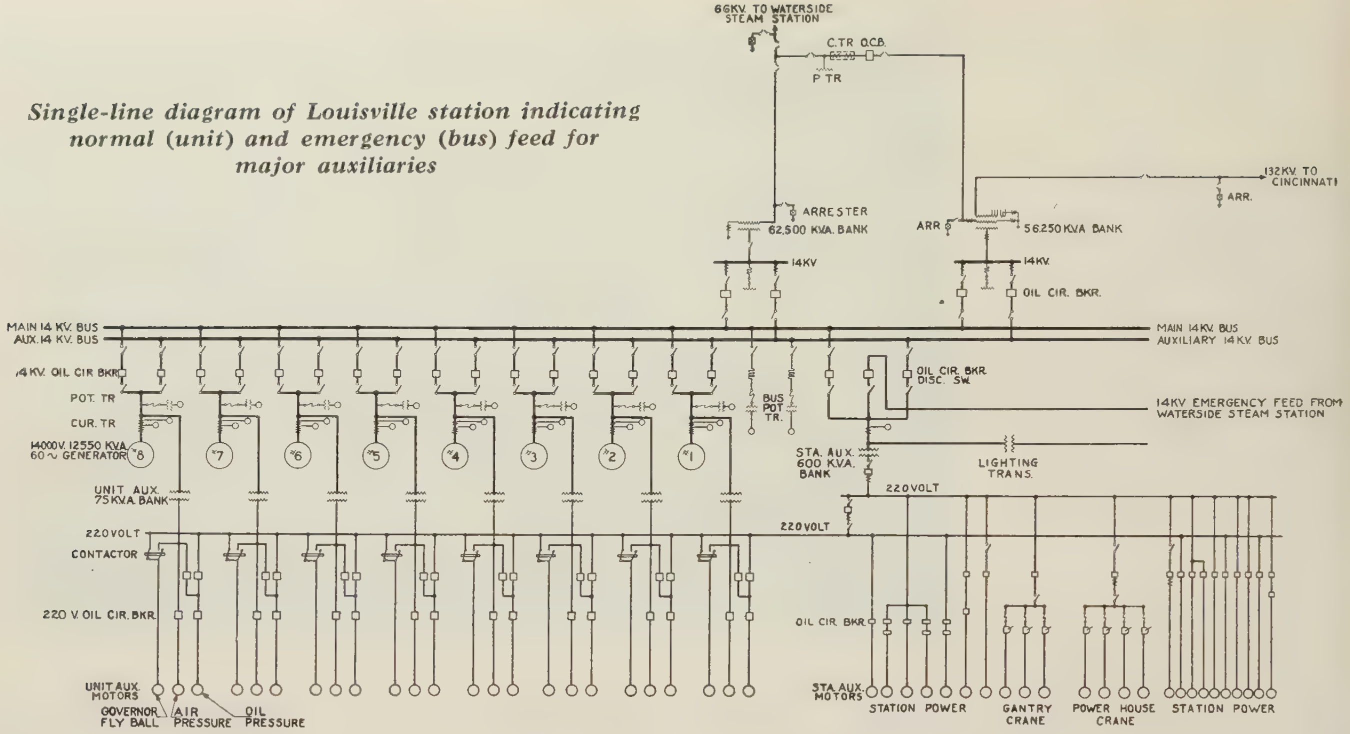
Three years of successful operation of the original lant, with successful installation and operation of later nportant additions, have demonstrated conclusively he entire justification of the departure from convenional layouts. It has been proved that the miniature witchboard accomplishes in a successful manner the entralized control and supervision of equipments videly separated physically. This has been done with ninimum space and cost and in such a way that future equirements may be met in an economical manner as hey develop and with no capital outlay in advance of he actual operating requirements.

Water supply for the Louisville plant comes through the Ohio River from a 91,000-sq. mi. area extending well into New York, Pennsylvania, Virginia, and Maryland. Conditions are such that the natural flow of the river varies from about 792,000 sec.-ft. at the time of maximum flood to 5,000 sec.-ft. or less during summer drought; whereas the present total water capacity of the plant is 32,000 sec.-ft. The 8,680-ft. dam, which was built in connection with the U. S. government's Ohio River canalization plan, is the longest and highest dam on the Ohio River. Together with the natural fall of some 28 ft. in the river bed at Louisville, a maximum operating head of 37 ft. is provided.

The water-level variation had much to do with the design of the station; to save in superstructure, the generator room floor is depressed 16 ft. below the entrance level which is 4 ft. above maximum high water, and water-wheels are placed near the low-water level. At present eight 13,500-hp. units (at 37-ft. head), are installed and provision is made for two additional units. Because of their ability to operate under heads varying from the maximum of 37 ft. down to 8 ft. five-blade propeller-type, axial-flow runners, designed to produce 13,500 hp. at 37 ft. net effective head at a speed of 100 rev. per min., were selected.

The 15-ft., 20-ton, cast-steel runner is connected to the rotor of the generator by 61 ft. of 23-in. shaft, the 125-ton combined weight of the assembly being suspended from a spring-type thrust bearing. Because of the long shaft four guide bearings, three of babbitt and one of lignum vitae, are used. Electrically driven flyball governors operated automatically provide positive control to servo motors and guide-vane latches, the latter being mounted directly on the cover plate to eliminate strains on the shift ring.

Single-line diagram of Louisville station indicating normal (unit) and emergency (bus) feed for major auxiliaries

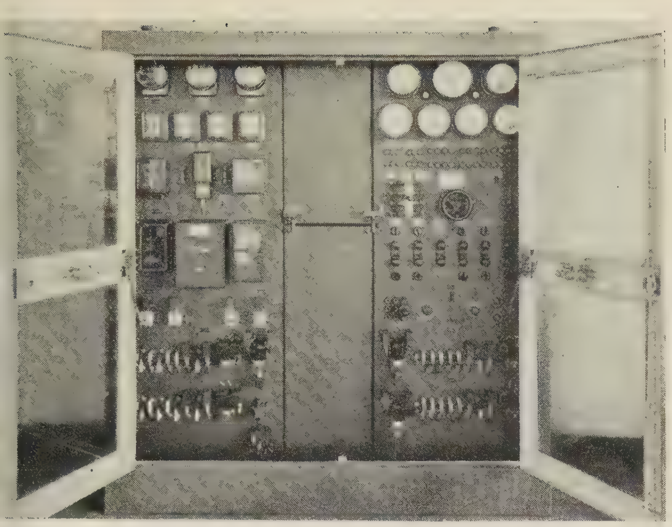


Each generator is rated at 12,550 kv-a., 14 kv. at 100 rev. per min. and equipped with direct-connected exciters mounted on the thrust-bearing housing. From the armature winding twelve leads are brought out to a terminal board to permit differential protection, and also for the purpose of changing the operating characteristics as desired. Normally for full-load operation the windings are connected two-circuit Y but for light loads they may be connected one-circuit delta. Improved efficiency of the delta connection as compared with the Y connection is computed to vary from 2.1 per cent at 10 per cent of full load to 0.5 per cent at 75 per cent of full load, 0.9 power factor. Above 75 per cent of full load the Y connection is used and normal efficiencies are obtained. Generator ventilation and cooling is accomplished through a totally enclosed system and all leakage air is made up through air filters to remove dust and dirt. The continuing clean condition of armature and field coils resulting from this ventilation system has kept the efficiency of the units at the original value.

Generator room of the Louisville plant showing the present eight 12,550-kv-a. generating units, each with its immediately associated switching and control equipment. Buses run the length of the power house in the sheet-steel enclosure along the upstream wall, back of the generators

One of the unit groups; (from the right) generator, hydraulic governor, supervised control and regulating cubicle, and two oil circuit breakers

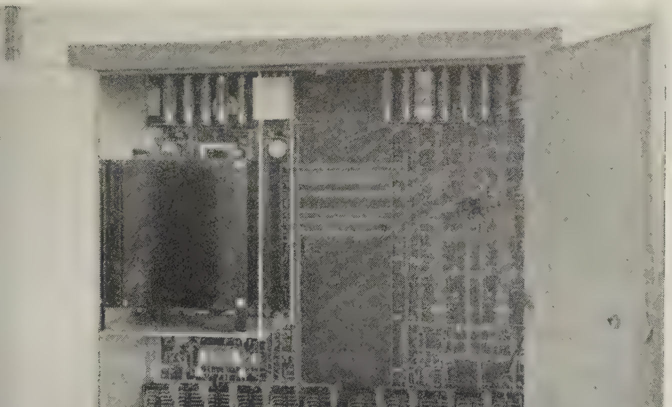
Manual and automatic control of the generators, outgoing lines, and station service banks is performed by means of standard panels and control equipment located in close proximity to the equipment controlled. For



Interior (front) of a generator cubicle which contains instruments for both manual and automatic control of its generating unit. Pull-button switches on doors and floor-attendant signal lights on top of cabinet may be noted also

rotection of the control equipment these switchboards ith associated relays, contactors, etc., are mounted in heet steel housings. Both control and meter circuits re brought to the switchboards by means of Greenfield able through multi-circuit train-type couplers. These ouplers facilitate maintenance and greatly expedite uick and complete isolation of the board.

Each hydroelectric generating unit is designed as a omplete station within itself with its individual auxil aries automatically and independently operated. Realizing that auxiliary failures mean jeopardized service, several additional features were included to insure dependable operation. The scheme of unit auxiliary equipment also is carried out as regards electrical equipment, in that all of the auxiliaries with the exception of compressed air for the brakes and the d-c. control voltage are fed directly from each generating unit.



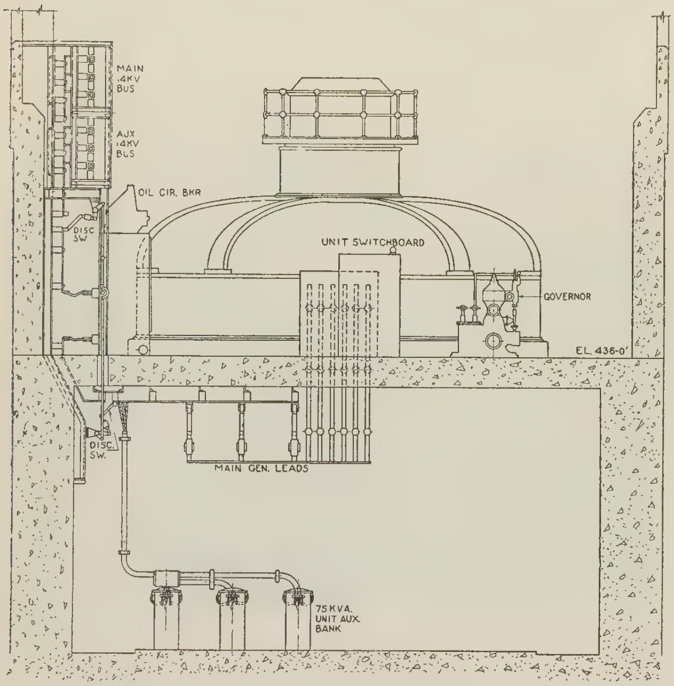
Rear of generator cubicle; train-type multi-circuit couplers expedite maintenance

During the starting period, the governor fly-ball and oil-pressure-pump motors are fed from a 230-volt station auxiliary bus. As the generator comes up to speed and 85 per cent of normal voltage is reached the governor fly-ball motor is transferred automatically to the unit feed. The governor oil-pressure motor is transferred manually from the station feed to the unit feed. The generator cooling-water pump motor is fed directly from the unit transformer bank at all times; as previously mentioned, excitation for the generator is from direct-connected exciters.

Central supervisory board with its four-inch panels

The miniature switchboard used to provide centralized control of the operations of the station is centrally located on the generator floor between units Nos. 4 and 5. The control equipment consists of a two-position control key for each circuit breaker or other device controlled, together with the usual red, green, and white signal lamps. In addition to the supervisory control keys the miniature board contains voltmeters, reactive volt-ampere meters, wattmeters, switches for raising and lowering load, and switches for regulating voltage. Control and meter circuits are taken from the supervisory panels by means of low-voltage telephone wires to a terminal box beneath the generator room floor. From that terminal box to an auxiliary terminal box near the unit switchboards lead-covered 16-pair telephone cable in rigid conduit is used, there being one such cable between the supervisory panels and each generator, transformer bank, and station auxiliary switchboard unit. Insulating, potential, and current transformers protect the small instruments on the supervisory board.

In the operation of the control equipment the operator at the supervisory panel selects by turning his bus selector key the bus to which the machine is to be synchronized giving the starting signal to the floor attendant by turning the "start and stop" control key to the "start" position; he also selects whether automatic or self-synchronizing is to be used in each particular instance. The floor attendant then checks to see that the gate limit stop is set for full-speed no-load value of head, and closes a pull-button control switch on the door of the generator cubicle to give the actual starting impulse to the unit. The usual assembly of protective and interlock devices prevents improper sequence in the operation and serves to shut down all related equipment when something goes wrong.

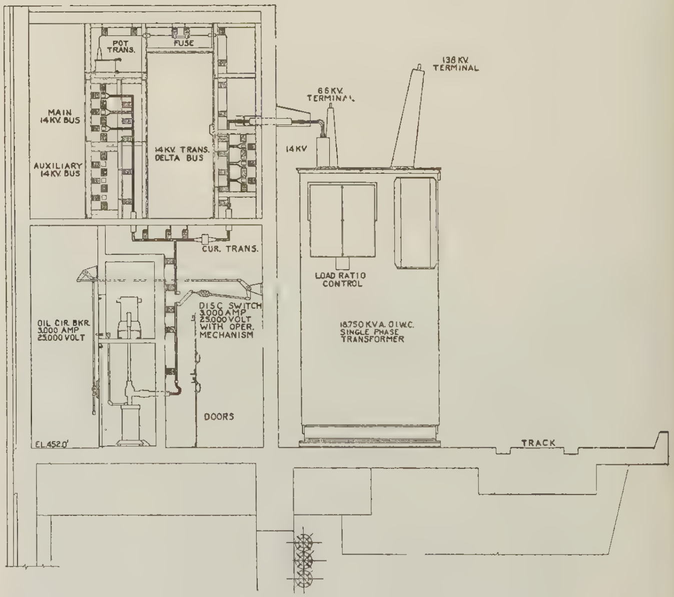


Generator leads are simplified with the unit grouping; main and auxiliary buses extend the length of the station

Operation of the Ohio Falls station depends entirely upon the flow of the river. Low water and small volume or the rapid and excessive rise of tailwater under flood conditions because of restrictions in the channel downstream, result in a curtailment of power output. The average yearly complete shutdown due to high water is 45 days. To meet navigation requirements the forebay pool is maintained as nearly constant as possible at El. 420, thus necessitating plant operation at the highest point of efficiency during low-water periods, at which time the plant operation is the governing factor of the pool stage. To meet emergencies for short periods all available equipment can be put into service within two minutes. Of course during periods when the flow exceeds the discharge capacity of the station, efficiencies are disregarded, and pool stages are controlled by a combination of manipulation of dams and plant operation.

Appreciable savings both in time and in labor costs in operating this plant have been realized as a result of the use of automatic control equipment. Only one switchboard operator is required on a shift, and where five floor men per shift would have been required for the eight generating units under other conditions, in this station only three are required.

Maintenance costs on the station have been even lower than were at first expected, which has given rise to the belief that the use of automatic equipment has resulted in less rather than in more maintenance. Experience shows that with the equipment once properly adjusted, the routine tests and inspection have been the smallest maintenance item. These tests are conducted weekly and require only the part time of one maintenance electrician.



Main transformer connections also are simplified

The miniature switchboard is expected to permit further economies and may even be removed to a future nearby steam station in which case one operator can control both stations.

Magnetic Circuit Units Adopted by I. E. C.

Standardized designations already adopted will obviate confusion if generally ratified; further international standardization of electromagnetic nomenclature is urged.

By Arthur E. Kennelly

Professor Emeritus of Electrical Engineering
Harvard University, Cambridge, Mass.
Fellow A. I. E. E.

AT a plenary meeting of the International Electrotechnical Commission (I. E. C.) held in Scandinavia n the summer of 1930 was conducted a series of nternational committee meetings on the subject of lectric and magnetic units. Agenda for that series of meetings had been prepared and distributed internationally many months in advance. In America a subcommittee on magnetic units of the U. S. national committee of the I. E. C. had held a number of meetings n New York, had prepared duly approved agenda for Scandinavia, and had distributed the same among the other national committees abroad.

Ever since the electrical congress at Paris adopted the C. G. S. magnetic units *maxwell* and *gauss* in 1900, here has been a growing confusion in international electrotechnical literature as to the proper use of the unit *gauss*. Some writers used the *gauss* as the unit or magnetizing force $\mathcal{H}$, others used it for magnetic flux density $\mathcal{B}$, and still others used the *gauss* for both $\mathcal{H}$ and $\mathcal{B}$ indiscriminately. This vagueness and lack of uniformity was not confined to the literature of any single country; it was found in that of all or nearly all countries and the confusion may be said to have become universal. There was, however, universal agreement upon the internationally accepted equation

$$\mathcal{B} = \mu \mathcal{H} \qquad (1)$$

where $\mathcal{B}$ is the flux density in a magnetizable medium, $\mathcal{H}$ the magnetizing force, and μ the permeability of the medium. In the case of a vacuum, or free space—*i. e.*, non-magnetic material—the same equation becomes

$$\mathcal{B} = \mu_0 \mathcal{H} \qquad \text{gausses} \qquad (2)$$

where μ_0 is the permeability of free space, which admittedly is equal numerically to unity in the C. G. S. magnetic system.

In equation (2), if space permeability μ_0 is a mere number unity, then both $\mathcal{B}$ and $\mathcal{H}$ are expressible in *gausses*; but if μ_0 has physical dimensions and is not a mere unit number, then $\mathcal{B}$ is expressible in *gausses* but $\mathcal{H}$ is different, and is expressible in some other unit.

The I. E. C. Scandinavian meeting decided unanimously in favor of the electrotechnical convention that μ and μ_0 are physical quantities and not mere numerics, and that $\mathcal{B}$ only should be expressed in *gausses*. For the expression of $\mathcal{H}$, a new unit name was adopted; namely, the *oersted*. In fact, Oersted was the Danish physicist who discovered at Copenhagen in 1820 the experimental fact, previously unsuspected, that a wire carrying an electric current exercises a deflecting magneto-mechanical torque or couple upon the poles of a suspended magnetic needle.

After reviewing the I. E. C. decisions on magnetic units as made at Oslo, recommendations for future consideration and discussion are made as follows:

(1) The I. E. C. decisions at Oslo to be ratified and generally adopted, thus eliminating confusion among magnetic units in the future.

(2) Another C. G. S. magnetic unit for reluctance might advantageously be adopted in the future. In America the *oersted* was used very generally as the unit of magnetic reluctance, but this had never been adopted internationally and the assignment of the *oersted* to magnetizing force $\mathcal{H}$ leaves a gap in the series of units expressing magnetic Ohm's law.

(3) A series of magnetic units in the practical or *volt-ampere-ohm* system might advantageously be considered in the future, commencing with the *pramaxwell* adopted at Oslo; but that before attempting any further international action on practical magnetic units, certain preliminary questions as to rationalization and also the particular system to be adopted, should first be studied, formulated, and internationally settled. This necessarily will take time.

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Electric Welding Advances in Modern Building Construction

CONSIDERING the new field arc-welded fourteen-story office building of the Edison Electric Illuminating Company (Boston) and a nineteen-story all-welded structure in Dallas, Texas, a few of the data on the Boston job as given by Frank P. McKibben in the *G. E. Review* (Dec. 1930) may be of something more than passing interest.

A combination of shop riveting and field welding effected the best use of facilities available. Steel erection was begun April 9, 1930, followed by the welding beginning on April 28, completion of erection June 26, and completion of welding June 27. Four

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From "Magnetic-Circuit Units as Adopted by the International Electrotechnical Commission" (**No. 31-7**) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

welding machines were used and seven welders chosen by competitive tests of their work. Of a total of 1,314 tons of structural steel in the structure, 1,050 tons were electrically welded with 2,080 lb. (net) of electrode in 1,205½ man-hours of labor and 6,120 kw-hr. of electric energy. Filet per ton of steel welded amounted to 57.63 in. with 50.2 in. deposited per welding man-hour. Filet deposited per eight-hour day amounted to 402 in.; per pound of wire melted, 29.09 in.; and per kw-hr., 9.9 in. Electric energy required per ton of building steel amounted to 4.66 kw-hr.; per ton of welded steel, 5.83 kw-hr.

Inspection service included (1) qualification and periodic tests of welders, (2) ascertaining the use of proper electrodes and current values, and (3) in verifying completed welds as to quality and as to size, length, and location in accordance with plans. A complete daily log was kept.

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The Oil-Blast Circuit Breaker

A further development of the explosion-chamber principle avoids the mixing of arc and oil in the main gap, utilizing the high oil pressure together with smooth and controlled flow of oil from the chamber to sweep away the arc, replacing it with a stream of clean oil. With this design tests show that a voltage of 44 kv. per inch across the working gap actually is reached.

By D. C. Prince and *W. F. Skeats*
Fellow A. I. E. E. Associate A. I. E. E.
Both of the General Electric Company, Schenectady

FOR MORE than thirty-five years the oil circuit breaker has been used as an interrupter for a-c. circuits and it still is the most practical, economical, and effective device so far developed for that purpose. In recent years much study has been given to the determination of the fundamental characteristics of the arc in oil as encountered in oil circuit breakers. One of the first important facts brought to light by these studies was that an unconfined arc in oil is extremely erratic in length, duration, and amount of gas formed. Even the maximum arc lengths vary in different sizes of breakers at the same currents and voltages, and in the same breaker are different with various opening speeds. These maximum values for various conditions and voltages have been determined from actual tests and are used as the design basis in plain-break breakers.

An excellent analysis of oil circuit breaker phenomena explaining the qualitative factors governing deionization rates in arcs, is to be found in the A. I. E. E. TRANSACTIONS, Vol. 49, 1930, pp. 421-446 ("Extinction of a Long A-C. Arc," by J. Slepian, and "The Use of Oil in Arc Rupture," by B. P. Baker and H. M. Wilcox.) The principle of confining the arc and maintaining a supply of oil in its immediate vicinity has been confirmed, although the means suggested differ considerably in operation from the method employed in the explosion chamber. The importance of low dissipation of energy in the arc in keeping down the mechanical stresses accompanying an interruption has been set forth, and a new structure has been developed for the purpose of accelerating the deionization of a mixed gas-and-oil arc path, so as to raise its dielectric strength during the short interval while the restoration of voltage across the breaker contacts is taking place.

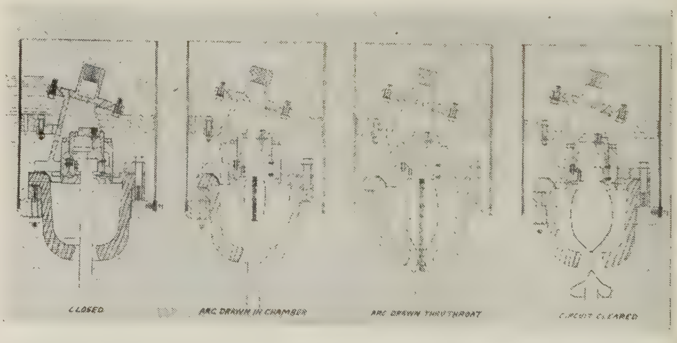

Fig. 1. Four successive stages in the operation of an ordinary explosion chamber

The deionization processes suggested, however, operate vigorously throughout the current cycle, requiring for an arc of given length, high voltage and energy dissipation and causing, therefore, a rapid evolution of gas. This is unavoidable where effective deionization at the current zero must be secured in a fairly homogeneous arc path. But the arc path at the time of rupture need not be homogeneous and it is the purpose of this paper to describe a process operating along entirely different lines.

For existing circuit breakers the arc path at the time of rupture has an effective dielectric strength of from about 2.5 kv. per in. in plain-break circuit breakers up to 10.0 kv. for the deion-grid breaker, and as high as 15.0 kv. for standard explosion-chamber circuit breakers. Clean oil has a dielectric strength of over

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From "The Oil-Blast Circuit Breaker" (No. 31-5) presented at the A. I. E. E. winter convention, New York, Jan. 26-30, 1931.

00.0 kv. per in., with a strength under impulse over 00.0 kv. per in. The introduction of any considerable mount of solid oil into the gap at the current zero ierefore holds possibilities of great improvement ver other methods of interruption.

Under the worst conditions line voltage may be npressed across a 15-kv. breaker in 10 microseconds. he rate of voltage rise is then $\sqrt{2} \times 1.5 \times 10^9$ volts er sec. Assuming the oil to have the dielectric trength it presents to impulse voltages, or about $\sqrt{2} \times 6 \times 10^9$ volts per in., fresh dielectric must be introduced at the rate of 200 ft. per sec. This velocity corresponds to a pressure of 255 lb. per sq. in., which is not an unusual explosion-chamber pressure.

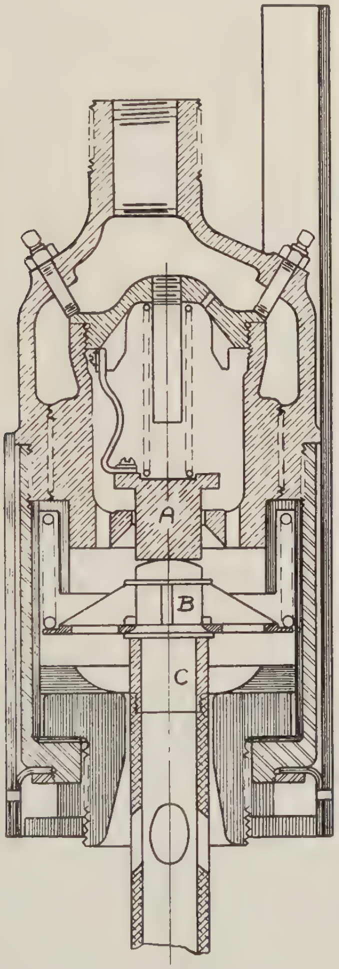


Fig. 2. Explosion chamber specially designed to utilize more effectively the kinetic energy of escaping oil to cut the arc

A high-voltage transformer will have a recovery rate corresponding to $\sqrt{2} \times 5 \times 10^9$ volts per sec. while the rate for a long-distance 220-kv. transmission line will be about $\sqrt{2} \times 0.8 \times 10^9$ volts per sec. even though the full voltage corresponds to 220 kv., line-to-line. It is quite possible to design a circuit breaker so that oil will sweep away the arc at the rate required by the foregoing calculations.

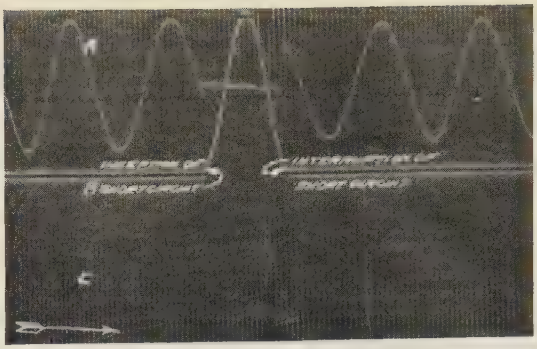


Fig. 3. Oscillogram of interruption of 24,800 amperes at 13.2 kv., 24 cycles, by an oil-blast breaker; (A) voltage across contacts; (B) line current; (C) tank pressure

Effectiveness of the explosion-chamber breaker may be explained in this way. Fig. 1 shows a standard high-speed explosion-chamber circuit breaker in four positions. In the first diagram the breaker is shown in the closed position; in the second, the contacts have separated and a small arc has been drawn which has decomposed sufficient oil to place the remaining oil in the explosion chamber under considerable pressure; in the third diagram, the moving contacts have reached the explosion-chamber throat and oil is being crowded in upon the arc in the throat; in the fourth diagram the

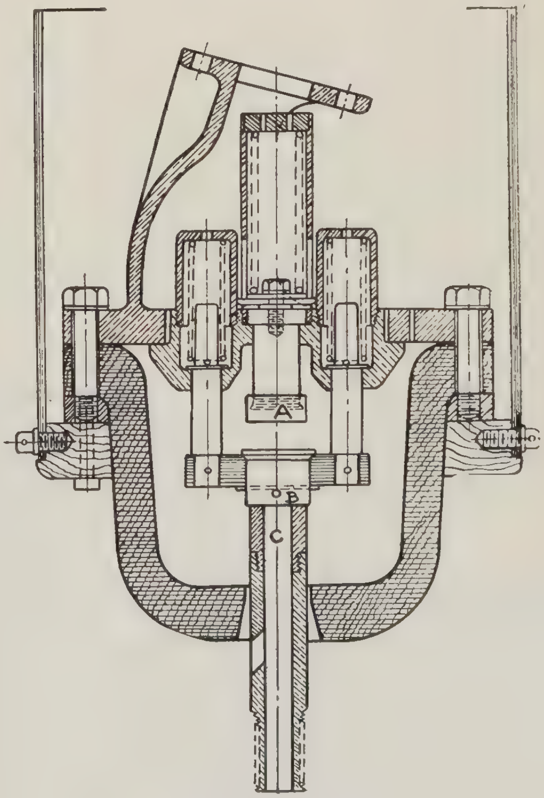


Fig. 4. Moulded oil-blast explosion chamber for a 110-kv. breaker

oil has divided the gas bubble into two parts, interposing a solid wall between them, and thus effectively opening the circuit.

As the gas bubble expands, driving the oil through the throat of the explosion chamber, the pressure varies from hundreds of pounds in the large part of the volume of the explosion chamber to a very low value actually in the throat; that is, the potential energy of pressure has been converted into kinetic energy of velocity. At the same time, since the pressure is low in the throat, the oil can very easily rush into this space so as to cut the arc in two.

TABLE I—TESTS OF 110 KV., 600 AMPERE OIL-BLAST CIRCUIT BREAKER

Feb. 6, 7 & 18, 1930

Voltage	Amperes	Arc duration		Kv. per in.
		Cycles	In. per break	
22 kv	1530–1880	0.8–2.2	0.8–2.6	4.2–13.7
44 “	3240–5000	0.5–1.5	0.5–1.7	13–44

To make this action even more positive the form of explosion chamber shown in Fig. 2 has been developed. It contains an upper butt contact *A*, a floating contact *B*, and a hollow contact *C*. When the breaker is tripped, the floating and hollow contacts, *B* and *C*, start down, driven by the opening springs, thus drawing a short arc between *A* and *B*. This arc forms gas and places the oil in the explosion chamber under pressure for which there is little relief until the floating contact reaches its stop. The secondary break and arc then occurs between contacts *B* and *C*; however, as the oil glides through the passageway in the contact rod, this arc is carried before it and exists alongside of it without mixing—hence with a minimum loss throughout the current cycle. Then, as soon as the current zero is reached, the arc products are displaced by a smoothly flowing wall of solid oil, the dielectric strength of which has not been impaired by carbonization or entrained ionized gas.

Several beneficial effects are obtained by the use of this modification: In the first place, the necessary arc length at generator voltages is reduced from something slightly in excess of the inside length of the explosion chamber to a little more than one inch per break. With a given contact speed this shorter arc can be established more rapidly—of decided advantage in cutting down the duration of short circuit and the arc-energy dissipation. The importance of reducing the energy from the points of view of (1) keeping down the mechanical stresses and oil deterioration resulting from a given interruption, (2) increasing the interrupting capacity of a structure of given size, and (3) minimizing the demonstration accompanying an interruption—has been previously established. In addition, the shorter arc duration results in less burning and longer life of the contact parts and of the oil. Also, both arcs are quite effectively kept away from insulating material so that burning of insulating parts is reduced. These two latter effects operate to cut down inspection and replacement requirements. Finally, the oil is more effectively directed into the second gap, so that the current range over which the chamber operates effectively is increased.

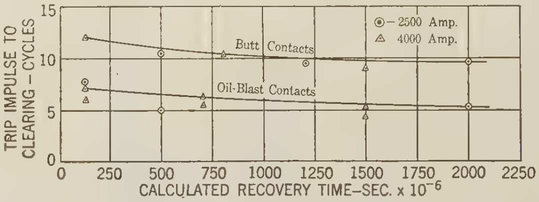


Fig. 5. Results of service tests of a 600-ampere 132-kv. oil-blast breaker

More than 250 tests have been made with currents from 900 to 25,600 amperes at 13.2 kv. and up to 56,400 amperes at lower voltages. Above 5,000 amperes the arc is uniformly extinguished at the first current zero occurring after the secondary contacts have been separated by as much as an inch; and in many cases the arc has been extinguished with a contact separation of but a quarter of an inch. Fig. 3 is a typical oscillogram showing the operation of this circuit breaker.

The need for high speed of interruption is fully as urgent at transmission voltages as at generator voltages. Accordingly, a somewhat larger explosion chamber was modified to correspond to Fig. 2. This arrangement was found to be effective up to 44 kv., as is demonstrated by the data in Table I. By comparison with the performance of the standard explosion-chamber breaker, the data shown in this table indicate consider-

TABLE II—TESTS OF 110-KV. 600-AMPERE OIL-BLAST CIRCUIT BREAKER

March 18 & 19, 1930

Kv.	Amperes	Arc duration		Arc energy	Kv-a. x 1,000	Watts-secs. Kv-a.	Kv. per In. in arc
		Cycles	In. per break				
66	2,020–2,940	1.75–3.00	5.25– 7.50	23–35	171–194	0.118–0.187	4.4– 6.3
88	1,890–2,210	2.25–3.75	5.25–11.00	14–58	166–194	0.084–0.350	4.0– 8.4
110	1,540–1,740	2.25–3.75	5.25– 9.00	11–36	169–191	0.059–0.199	6.1–10.5
132	790–1,570	2.25–6.00	4.50–21.90	18–65	104–207	0,087–0.458	3.0–14.7

Contact burning negligible. No-load speed 7.8 ft. per sec.
Oil deterioration negligible.
No measurable pressure above oil.

ble improvement. Whereas with the standard ex-losion chamber, arc lengths vary from four to eight nches, those in Table I vary from 0.5 to 2.5 in.

At 110 kv., however, it was found more desirable to ubstitute molded explosion chambers for the steel hambers used at the lower voltages. Detailed arrangement of these chambers is given in Fig. 4. Oscillograms show that with this combination the arc duration s about three cycles, and both arc drop and arc energy re very low. Results of many tests are shown in Table II.

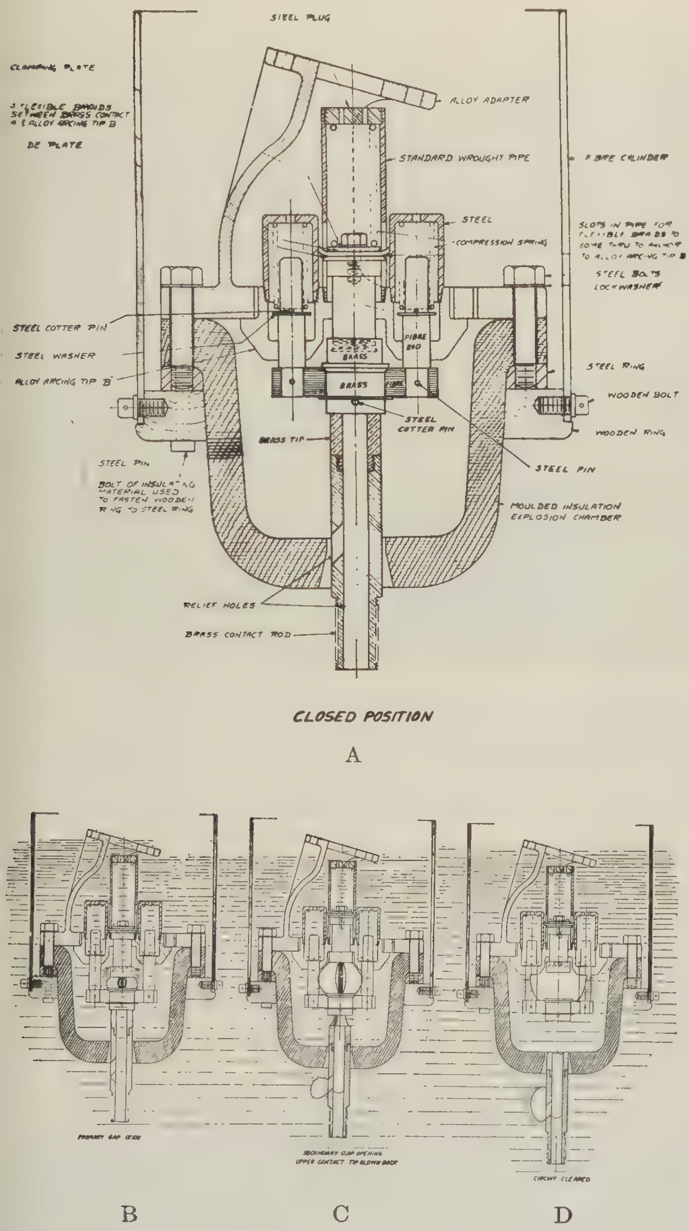


Fig. 6. Distribution of arcs and gas in four steps of operation of an oil-blast breaker

A 132-kv., 600-ampere breaker with the explosion-hamber arrangement just described was installed and tested under short-circuit conditions at the Philo plant of the American Gas and Electric Company. Its actual over-all interrupting time as compared with an ordinary butt-contact explosion-chamber breaker is revealed in Fig. 5. Field data gathered in these tests are presented and discussed in a paper prepared and presented by R. M. Spurck and H. E. Strang, at the winter convention in New York Jan. 26-30, 1931. The gain in the case of the oil-blast contacts is more impressive when it is remembered that in both cases the mechanical time required to separate the contacts is the same.

During the tests it was found that in many cases the circuit has been successfully opened with chamber pressures less than those previously calculated as theoretically necessary. This is explained by a more complete analysis of the oil flow during the arcing period.

Fig. 6 shows a series of drawings representing the locations of arcs, gas, and contacts during an operation of the breaker; Fig. 6A, the contacts in the closed position and in Fig. 6B the upper contacts have parted, establishing the pressure-generating arc. In Fig. 6C the lower contacts have parted and the current is still considerable, giving a fat arc. It is, however, beginning to be carried down the contact tube—which has been freed of oil—and gas is commencing to escape from the vent holes. As the arc dwindles with the cyclic decay in current, the oil moves radially inward along an area many times larger than the bore of the contact tube. At the current zero (Fig. 6D) the velocity of gas moving downward into the tube becomes many times the velocity of the inward-flowing oil. In effect the rate at which solid oil dielectric replaces ionized gas is the velocity with which the gas can go through the bore of the contact rod. The gas may pass through the contact tube at the velocity of sound, 2300 ft. per sec. in oil circuit breaker gas at ordinary temperatures, while at arc temperatures it probably exceeds 10,000 ft. per sec., which accounts for the extraordinary rate at which the space once occupied by the arc recovers its dielectric strength.

The principle of employing oil only instead of mixed oil and gas as the interrupting medium in oil circuit breakers is not limited to the larger types; smaller types applying this principle are under development and tests already made indicate that large decreases in arc length and increases in interrupting capacity will be obtained in all cases.

As relatively newcomers in the oil circuit breaker field, the authors would have been utterly unable to obtain the results which have been yielded by this investigation without the fine cooperation of the General Electric Company. Specifically Messrs. W. K. Rankin and W. E. Paul have contributed many of the ideas on which this paper is based, while G. F. Davis and his testing staff has made possible important checks upon theory, as well as the determination of the performance characteristics of the final designs.

News
Of Institute and Related Activities

—Photo by Altwater & Bros., Pgh.

Pittsburgh, host city to the Institute in March, offers many features of interest

Middle Eastern District Offers Promising Program for Pittsburgh Meeting

IN high technical values as well as in the diversive attractions offered by a membership gathering, the March meeting of the Institute's Middle Eastern District No. 2 will offer material which none can well afford to miss. The William Penn Hotel, Pittsburgh, Pa., will be headquarters, and the many additional possibilities afforded by the Pittsburgh area will be made available to our guests by the plans which the local committees are formulating. The city itself, possessed of rare scenic beauty, has elevations offering an unusual panoramic view of the junction of the Allegheny and Monongahela rivers where they unite to form the Ohio River; its geographic location is such as to make it a major center of distribution; its endowment of natural resources in the surrounding hills, too, make for a great manufacturing center—the "Steel and Electric City." As far as the eye can scan, span after span bridge the rivers, with traffic—train, boat, vehicular and pedestrian—unceasingly present; while the auxiliary municipalities with which the river banks are lined make the constantly stirring action of the area doubly interesting to the mind of the energetic engineer.

The technical program will include papers on such all-important subjects as the interconnections between utilities and industry, a description of the new primary network now being installed in Pittsburgh, a symposium on the latest methods of grounding, relaying and fault-correcting for transmission systems (including another paper by Miss Edith Clarke), the miscellaneous applications of power to industry, and a live discussion of today's communication problems.

Briefly stated, the program is as follows:

OUTLINE OF PROGRAM

WEDNESDAY, MARCH 11, 1931

9:00 a. m.	Registration
10:00 a. m.	Address of Welcome—President William S. Lee
10:15 a. m.	Technical Session No. 1
2:00 p. m.	Technical Session No. 2
8:15 p. m.	Theater Party

THURSDAY, MARCH 12, 1931

9:30 a. m.	Technical Session No. 3
12:30 p. m.	Luncheon for Student Branch Counselors and Chairmen
2:00 p. m.	Student Session
2:00 p. m.	Inspection Trips
6:45 p. m.	Banquet and Dance

FRIDAY, MARCH 13, 1931

9:30 a. m.	Technical Session No. 4
12:30 p. m.	Luncheon for Student Branch Counselors
2:00 p. m.	Technical Session No. 5

ENTERTAINMENT

On Wednesday evening tickets for any of the Pittsburgh theaters may be obtained at the registration desk.

Thursday evening's social events will be the banquet and dance held in the main ballroom of the William Penn Hotel. An excellent program of music has been prepared by Pittsburgh's leading orchestra; favors for the ladies, and other special features will enhance the pleasure of the occasion. Reservations may be made in advance for tables seating ten persons; the tickets will be $4.00 each.

LADIES' PROGRAM

For the ladies' entertainment the Ladies Committee has arranged a sightseeing trip and tea on Wednesday afternoon, a luncheon and bridge on Thursday afternoon, and an indoor golf tournament and luncheon Friday morning.

INSPECTION TRIPS

The following inspection trips, which will afford an opportunity to see many recent developments of interest to the electrical engineering profession, have been planned for Thursday afternoon, March 12th:

1. The new KDKA broadcasting station at Saxonburg, Pa.
2. The East Pittsburgh Works of the Westinghouse Electric & Manufacturing Company, including the new Central and High-Power Laboratory.
3. The Homestead Works of the Carnegie Steel Company.
4. The Springdale Power Station and Coal Mine of the West Penn Power Company.
5. The James H. Reed Power Station of the Duquesne Light Company.
6. The new 4000 volt primary network of the Duquesne Light Company.
7. The low-tension alternating-current network of the Duquesne Light Company.
8. The Bell Telephone Building, Pittsburgh.

A description of each of these trips with details of transportation, time, etc., will be announced in the program distributed prior to, and during the meeting.

In addition to the above, special inspection trips will also be arranged upon request; *i e.*, to the Lake Lynn Hydro Station of the West Penn Power Company, or to other points of interest in the Pittsburgh district.

RAILROAD INFORMATION

Train reservations may be made at the hotels; further train information will be available at the meeting's information desk. There will be no special railroad rates.

REGISTRATION

Each member should register in advance by mail, thus permitting the early preparation of badges and the saving of considerable time and confusion at the registration desk.

Full information regarding the entire program will be mailed in advance to each member in the district; also a registration card, which should be returned promptly.

COMMITTEES

The personnel of the General Meeting Committee consists of the following: E. C. Stone, Vice-President, Middle Eastern District, No. 2; J. A. Cadwallader, Secretary, Middle Eastern District, No. 2; C. T. Sinclair, Chairman, General Committee; F. W. Braund, H. E. Dyche, F. C. Hanker, D. H. Kelly, H. C. Paiste and W. R. Work. Those who are making the local arrangements for the meeting are as follows: C. T. Sinclair, Chairman, General Committee; and the following who are chairmen of sub-committees: A. G. Butler, Inspection Trips; J. A. Cadwallader, Finance; Miss Karen Fladoes, Ladies Entertainment; F. C. Hanker, Meetings and Papers; Moreland King, Student Activities; R. L. Kirk, Publicity; J. A. MacGregor, Hotel Registration and Train Transportation; and W. B. Spellmire, Entertainment.

HOTEL RESERVATIONS

Reservations for hotel accommodations should be made by writing directly to any one of the following hotels; William Penn, Fort Pitt, Pittsburgher, or Roosevelt. All of these are within easy walking distance of headquarters.

By special arrangement delegates may enjoy the privileges of the Keystone Athletic Club by making reservations through J. A. MacGregor, Bell Telephone Company, 19th floor, 416 Seventh Avenue.

The Engineers' Society of Western Pennsylvania, located in the basement of the William Penn Hotel, also have kindly offered the facilities of their club rooms to visiting engineers at the District meeting. These facilities include a very large and comfortable club room well furnished with magazines, card tables, and miscellaneous equipment. Delegates are urged to make full use of the facilities, which will be found a very great added convenience and pleasure during their stay.

In the matter of special hotel rooms desired for committee meetings, reservations should be made through Mr. MacGregor at the address given above.

Further information regarding hotel accommodations and rates will be included in the announcement to be mailed later.

Technical Program

Wednesday, March 11—10:00 a.m.

Opening of Meeting

E. C. Stone, Vice-President, Middle Eastern District No. 2.

Address of Welcome, William S. Lee, President, American Institute of Electrical Engineers.

—Photo by L. F. Beaudry, Pgh.

Lake Lynn hydroelectric development of the West Penn Power Company

Session No. 1—On Cable Arcs and Arcs in Air

Sponsored by the Subcommittee on Distribution of the Power Transmission and Distribution Committee.

Burn-Off Characteristics of Low-Voltage Network Cables, G. Sutherland and D. S. MacCorkle, New York & Queens Electric Light & Power Company.

Arcs in Low-Voltage A-C. Network Cables, J. Slepian and A. P. Strom, Westinghouse Electric & Manufacturing Company.

The Re-ignition of Metallic A-C. Arcs in Air, S. S. Atwood, W. G. Dow, and W. Krousnick, University of Michigan.

Wednesday, March 11—2:00 p. m.

Session No. 2—On Distribution Networks

Sponsored by the Subcommittee on Distribution of the Power Transmission and Distribution Committee.

Vertical Networks in Metropolitan Office Buildings, A. H. Kehoe, United Electric Light & Power Company, and Bassett Jones, Consulting Engineer.

The Primary Network, R. M. Stanley and C. T. Sinclair, Byllesby Engineering and Management Corporation.

Operating Experience with Philadelphia A-C. Network, H. S. Davis and W. R. Ross, Philadelphia Electric Company.

Prepared discussion—arrangements will be made for interested engineers to present prepared discussions on the problems involved in network distribution systems.

Thursday, March 12—9:30 a. m.

Session No. 3—On Grounding, Relaying and Transmission

Sponsored by the Protective Devices Committee.

Committee Report on Present Day Grounding Practises, C. A. Powel, Chairman.

Reactance of Transmission Lines with Ground Return, J. E. Clem, General Electric Company.

Fundamental Basis of Distance Relaying, W. A. Lewis, Westinghouse Electric & Manufacturing Company.

Power System Voltages and Currents Under Fault Conditions, R. D. Evans and S. H. Wright, Westinghouse Electric & Manufacturing Company.

Simultaneous Faults and Six-Phase Transmission, Edith Clarke, General Electric Company.

Thursday, March 12—2:00 p. m.

Student Session

Address, William S. Lee, President, American Institute of Electrical Engineers.

Summer Employment for Engineering Students, Wm. D. Bruce, University of Pennsylvania, and M. M. Boring, General Electric Company.

Qualifications Looked for in a Cadet Engineer, Lewis Fussell, Jr., Swarthmore, College, and Dr. E. B. Roberts, Westinghouse Electric and Manufacturing Company.

Has the Student Branch any Responsibilities to the Freshman and Sophomore? P. W. Seal, Lehigh University and G. A. Sanow, Case School of Applied Science.

A Review of Student Branch Activities in District No. 2, Professor J. T. Walther, University of Akron.

Friday, March 13—9:30 a. m.

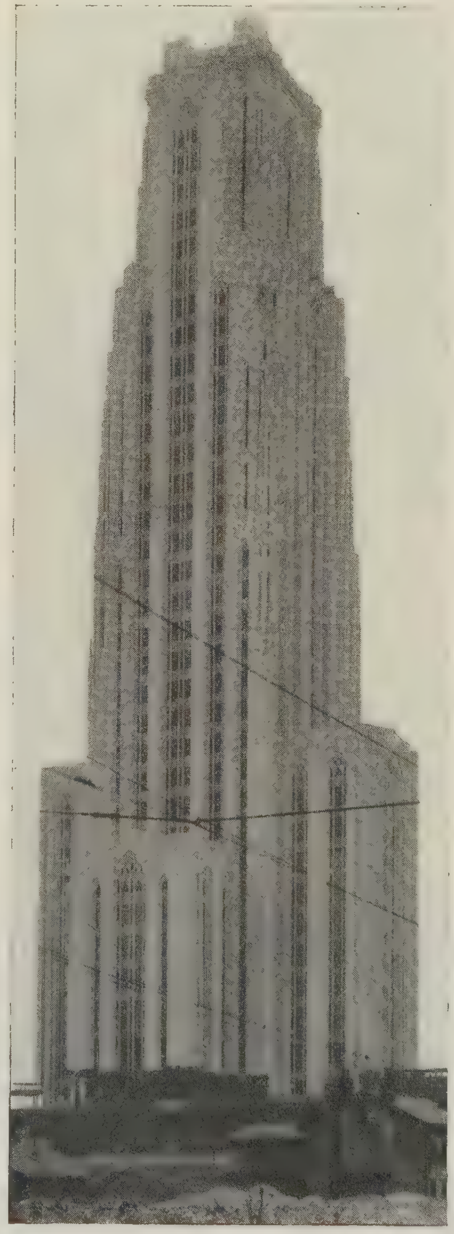
Session No. 4—Selected Subjects

Part I

Conversion and Distribution of General Purpose D-C. Power in Large Industrial Plants, R. D. Abbiss, Carnegie Steel Company, and D. C. West, Westinghouse Electric and Manufacturing Company.

Part II—Symposium on Interconnection between Utilities and Industries.

Interconnection Between the Duquesne Light Company and the Davison Coke & Iron Company, G. E. Dignan, Davison Coke & Iron Company, and R. L. Kirk, Duquesne Light Company.



A vertical campus; the University of Pittsburgh's Cathedral of Learning is nearing completion

Interconnection for Power Between Public Utilities and Large Industrial Users. F. O. Schnure, Bethlehem Steel Company.

Absorption of By-Product Power, A. Hoefle, Toledo Edison Company, and W. T. Woodmancy.

All the papers in this Session will be reprinted by the Association of Iron and Steel Electrical Engineers.

Friday, March 13—2:00 p. m.

Session No. 5—Selected Subjects

Part I—Industrial Power Applications

The Use of Electricity in Large Annealing Furnaces, J. C. Woodson, Westinghouse Electric & Manufacturing Company.

The Use of Electricity in a Modern Dairy Plant, H. C. Brunner, Westinghouse Electric & Manufacturing Company, and A. G. Droux, Rieck McJunkin Company.

Part II—Communications.

Description of KDKA Broadcasting Station, R. L. Davis, Westinghouse Electric & Manufacturing Company.

Power Supply for Telephone Systems, R. L. Young and R. L. Lunsford, American Telephone & Telegraph Company.

Power Supply for Telegraph Systems, E. W. Griffith.

Recent Developments in the Operation of Overseas Telephone Service, F. A. Cowan, American Telephone & Telegraph Company.

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Pacific Coast Convention Plans Announced

Taking advantage of the natural beauties and other attractive features of California's famous Lake Tahoe, the San Francisco Section, hosts to the 1931 Coast convention of the Institute have decided to hold that gathering at the mile-high lake resort. Facilities for technical inspection trips are generous and recreational possibilities are claimed to be second to none. Transportation both by rail and automobile is convenient, and excellent provisions are available for the convenience of family groups; hence there is the invitation to "make it your family vacation trip."

Tentative dates set are August 25-29 inclusive, a time chosen to synchronize with school terms.

Committee Appointments

Convention committee chairman as announced include A. W. Copley, general chairman; P. B. Garrett, general vice-chairman; E. F. Maryatt, general secretary; A. G. Jones, entertainment; E. A. Crellin, finance and hotel; A. V. Thompson, Golf; F. R. George, inspection trips; W. C. Heston, publicity; M. S. Barnes, registration; C. E. Fleager, (Eighth District vice-president) reception; D. I. Cone, technical program; Prof. S. G. Palmer, student activities; Paul Lebenbaum, transportation.

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Units and Definitions Adopted by International Electrotechnical Commission

INTERNATIONAL agreement on the definitions and names of additional magnetic units was reached by the International Electrotechnical Commission at its meeting in Oslo (Scandinavia) July 1930. This constitutes a further important advance in the standardization of electromagnetic units brought about through the efforts of this commission. The following is an unofficial summary of the actions taken:

The story begins with the preceding plenary I. E. C. meeting in 1927 at Bellagio, when a proposal was presented by the Italian National Committee, to adopt a unit of magnetic flux Φ, in the practical or volt-ampere-ohm system of units, with a certain definite name. For consideration and report the proposal was referred to a special subcommittee of advisory committee No. 1, on nomenclature to be known as the Subcommittee on Magnetic Units, and comprised of one representative from each of seven National Committees (France, Germany, Great Britain, Holland, Italy, U. S. A. and U. S. S. R.).

The members of this subcommittee exchanged much friendly correspondence upon the subject; but their views differed materially and no consensus of opinion could be reached. It was therefore decided to ventilate the question by papers and discussions in the various countries and I. E. C. national committees, with a view to paving the way for international agreement at the 1930 plenary Scandinavian meeting.

The I. E. C. Subcommittee on Magnetic Units agreed to attempt a revision of the C. G. S. units adopted at Paris in 1900, but in order to do so, it was first necessary to reach international agreement on the fundamental definitions of the C. G. S. magnetic units, and especially of magnetic permeability μ, on which question, differences of opinion have appeared in nearly all countries.

It is universally agreed that in a vacuum or in free space, with C. G. S. units, a uniform magnetising force $\mathcal{H}$ produces a uniform flux density $\mathcal{B}$ of the same numerical value; so that *space permeability* μ_0, or the ratio $\mathcal{B}/\mathcal{H}$, in free space, is unity. It has been much debated, however, whether, admitting that $\mathcal{H} = 20$ say, produces also $\mathcal{B} = 20$ in free space, the flux density $\mathcal{B}$ is identically the same physical quantity as $\mathcal{H}$; or whether the $\mathcal{H}$ sets up a quantity $\mathcal{B}$, which, although numerically the same, is physically different. If $\mathcal{H}$ and $\mathcal{B}$ are physically identical, it is not only superfluous but misleading to call them by different names and give them different units. The same unit *gauss* if applied to one would necessarily apply to the other. If, on the contrary, flux density $\mathcal{B}$ differs essentially from magnetising force $\mathcal{H}$; then it becomes necessary to have different units for these quantities, even if agreement cannot be reached as to the absolute dimensions of $\mathcal{B}$ and $\mathcal{H}$ in terms of length, mass, and time.

Decision at Stockholm on the Question of Permeability

At the first meeting of the Subcommittee on Magnetic Units, it was unanimously agreed to accept the hypothesis that for electrotechnical purposes, $\mathcal{B}$ and $\mathcal{H}$ in free space have different physical dimensions; so that their ratio μ_0 the space permeability, is a dimensional quantity and not the mere numeric unity (in the C. G. S. system).

It was also unanimously agreed that the ratio μ/μ_0 of the absolute permeability of a magnetic substance such as steel to the space permeability should be called its *relative permeability*, and should be taken as a pure numeric. Consequently when speaking of steel at a certain magnetising force as having an *absolute permeability* μ, of, say, 1,000, this is a dimensional quantity of the same dimensions as *space permeability* μ_0; but if we speak of its *relative permeability* μ/μ_0 as being 1,000, we refer to a mere numeric.

Formation of I. E. C. Subcommittee on Units and Magnitudes

The Subcommittee on Magnetic Units was enlarged in scope and membership by the I. E. C. committee No. 1 on nomenclature, with the new title, "Subcommittee on Electric and Magnetic Units and Magnitudes," and representatives of four additional national committees were appointed to it. The new subcommittee (E&M U&M) has one representative from each of the following national I. E. C. committees: France, Germany, Great Britain, Holland, Italy, Norway, Poland, Roumania, Spain, U. S. S. R. and U. S. A.

Names Adopted for C. G. S. Magnetic Units

The permeability question having been settled unanimously, the new subcommittee adopted either unanimously or by a large majority the following names for C. G. S. magnetic units:

For magnetomotive force (force magnetomotrice) . . . $\mathcal{F}$ the name *gilbert*
For magnetising force (champ magnetique) . . . . $\mathcal{H}$ the name *oersted*
For magnetic flux (flux magnetique) . . . . Φ the name *maxwell*
For magnetic flux density (induction) . . . . $\mathcal{B}$ the name *gauss*

It was urged on behalf of the Danish National Committee, that although the name oersted had been used in America for the C. G. S. unit of reluctance, yet this had never been adopted internationally; moreover, that Oersted had not interested himself in reluctance; but had actually discovered the magnetic field produced by an electric current. Consequently, it would be more rational to adopt the name *oersted* internationally for the unit of $\mathcal{H}$ than for the unit of R.

The following units in the C. G. S. magnetic system are thus left for the present without names;—reluctance, reluctivity, permeance, and permeability however, these are units the names of which can be most readily spared by electrotechnicians.

For Use in the Practical System

In conformity with the Italian committee's proposal of 1927, the subcommittee unanimously adopted a practical unit of magnetic flux Φ with the value of 10^8 C. G. S. units, and with the name *pramaxwell*. (The prefix *pra* may be regarded as a contraction of the adjective "practical"—in French, "pratique"). It was also agreed to adopt the prefix *pra* as applicable for deriving practical units from corresponding C. G. S. units.

It was pointed out during the review of the subcommittee's resolutions by the main committee on nomenclature, that the *pramaxwell* as above defined was a definite unit magnitude and unit name concerning which there could be no misunderstanding or confusion; but that otherwise might be the case were attempts made to produce other practical magnetic units from the remaining members of the C. G. S. series. For instance misunderstanding and confusion might arise by using *pragilbert, praoersted, or pragauss.* This is because there are at least three different systems of "practical" units recognized today; namely, (a) the quadrant-eleventh-gram-second system of Maxwell; (b) the meter-kilogram-second system of Giorgi, and (c) the centimeter-gramseven-second system of Dellinger, Bennet, Karapetoff and Mie. Moreover, each of these three systems is sometimes claimed to be "rationalised" in modern technics, by the transfer of the factor 4 π from magnetomotive force to reluctance. There might thus be at least two possible values for the "*pragilbert*" and six possible values for the "*pragauss*." Under these conditions so far as concerns the prefix *pra* it seems desirable, at least for the present, to limit the names for practical magnetic units to the *pramaxwell*. Of course the *ampere-turn* is a practical unit of magnetomotive force that has long been available and is free from ambiguity.

UNIT OF FREQUENCY

It was proposed by the German national committee to adopt the *hertz* as the international name of the unit of frequency, with the value of one cycle per second; but it was found impossible to reach agreement on this proposition, which was therefore referred back to the subcommittee for further consideration.

REACTIVE UNITS RELATING TO A-C. CIRCUITS AND SYSTEMS

The name *var* was adopted on a proposal of the Roumanian national committee, for the practical unit of reactive power in an a-c. circuit or system. This name *var* may be regarded as a contraction of the term "volt-ampere-reactif" or "reactive volt-ampere." The ordinary right-angle triangle, representing a-c. power, may thus be regarded as having *watts* for its base, *vars* for its perpendicular, and *volt-amperes* for its hypotenuse.

From the *var* the *kilovar* of 1,000 *vars* is derived in the regular way, expressible in the contracted form of *kvar*. Similarly, the product of the *var* and the hour gives rise to the *varhour*, expressible in the contraction *varh*, and likewise the *kilovarhour* in the form *kvarh*.

It was proposed to adopt the term "hormanance" derived from a Greek verb meaning "excitation" as designating reactive power; but the motion was lost, and the matter was left for further study. It was then agreed to adopt provisionally the term "reactive power" itself. Thus, the a-c. power triangle would have *active power* as its base, *reactive power* as its perpendicular, and apparent power as its hypotenuse.

DEFINITION OF POWER FACTOR IN A SINUSOIDAL A-C. SYSTEM

In accordance with a proposal of the Roumanian national committee it was agreed to define the power factor of a sinusoidal a-c. system in the steady state by the numerical value of the expression: $P/\sqrt{P^2 + P_r^2}$, either as a perunitage or a percentage; where P is the total active power of the system in *watts*, and P_r is the total reactive power of the system in *vars*.

DEFINITION OF POWER FACTOR IN A SINGLE-PHASE NON-SINUSOIDAL CIRCUIT

For the case of the general non-sinusoidal a-c. circuit it was agreed to adopt provisionally as the definition of the power factor, the numerical value of the expression: $P/(V\ I)$ where P is the active power in watts, and $V\ I$ is the apparent power, expressed as the product of the volts V and the amperes I.

Certain other subjects connected with reactive components in a general non-sinusoidal a-c. system were assigned for future discussion in the subcommittee, and also certain ambiguities in the use of existing electric and magnetic units. The hope was expressed that the appearance of premature and ill-considered new units in electrotechnical literature may be prevented by the work of the I. E. C. subcommittee on E&M U&M, to which the national committees may refer such questions advantageously for international consideration.

The resolutions of the Subcommittee on Electric and Magnetic Units and Magnitudes were reviewed and unanimously adopted by the main advisory committee No. 1 on nomenclature; thence reported to the plenary meeting of the I. E. C. in Oslo, July 9, 1930, where they were unanimously adopted.

NOTE: In connection with the adoption of the name *oersted* for the C. G. S. magnetic unit of magnetising force $\mathcal{H}$, as above outlined, it may be of interest to note that on June 27th, the opening day in Copenhagen, an official visit was made to the Oersted Statue in a park of that city. In the statue, Oersted is represented as observing the deflecting action of a voltaic-battery current upon a magnetic needle. With appropriate ceremonies, President Feldmann deposited at the base of the statue a suitably inscribed floral wreath.

(Signed) A. E. KENNELLY, Chairman,
Subcommittee on
Magnetic Units of the
UNITED STATES NATIONAL
COMMITTEE, I. E. C.

◆ ◆ ◆

1929 Census of Manufactures for Electrical Apparatus Shows 39% Increase

Announcement is made by the Bureau of the Census, Washington, D. C., December 31, 1930 that, according to preliminary tabulation of data collected in the Census of Manufactures taken in 1930, the total value of electrical machinery, apparatus, and supplies manufactured during 1929 in the United States amounted to \$2,323,597,927, an increase of 39.3 per cent as compared with \$1,668,104,965 for 1927, the last preceding census year.

The total for 1929 consisted of: Insulated wire and cable, \$296,858,831; motors, exclusive of fan motors, \$185,233,201; batteries, battery parts, and supplies, \$145,207,574; industrial, commercial and domestic apparatus and appliances, \$100,698,743; incandescent lamps, \$85,319,515; switchboards, circuit breakers, and switches \$79,424,219; transformers, induction voltage regulators, and current-limiting reactors, \$78,114,532; generating apparatus and parts, \$68,131,815; ignition apparatus for internal-combustion engines, \$54,426,944; conduits and fittings, \$46,915,073; wiring devices, \$43,120,093; control apparatus, \$42,541,032; measuring instruments, relays, and instrument transformers, \$38,328,070; electrotherapeutic and electromedical apparatus, \$19,957,011; fuses and fuse blocks, \$13,420,285; electric fans, \$11,560,642; miscellaneous electrical equipment, \$936,059,847.

Of the total, \$2,217,634,994 was contributed by those engaged primarily in the manufacture of electrical machinery, apparatus, and supplies, and the remaining \$105,962,933 represented the value of such commodities made as secondary products by establishments engaged primarily in other lines of manufacture.

This industry embraces establishments engaged primarily in the manufacture of machinery, apparatus, and supplies for employment directly in the generation, storage, transmission, or utilization of electric energy. It does not cover establishments whose principal products are electric-lighting fixtures, electric signs, or motor-driven tools, mechanical refrigerators, washing machines, or other machines and appliances constructed with built-in motors, ignition apparatus, or other electrical equipment, unless the electrical equipment is made by the manufacturers of the machines or appliances and its value constitutes at least one-half of the total value of the machines or appliances.

Table I, below, gives summary statistics for the industry, for 1929 and 1927; Table II shows the values of the several broad classes or groups of products manufactured in 1929 and 1927. The figures for 1929 are preliminary and subject to revision.

TABLE I—SUMMARY FOR THE INDUSTRY: 1929 AND 1927

	1929	1927	Per cent of increase or decrease (−)
Number of establishments	1,798	1,177	1.2
Wage earners (average for the year)[1]	329,361	241,566	36.3
Wages[2]	$455,294,638	$336,238,750	35.4
Cost of materials, containers for products, fuel, and purchased electric current[2]	$921,190,963	$645,761,699	42.7
Products, total value[2]	$2,286,273,042	$1,637,307,035	39.6
Electrical machinery, apparatus, and supplies	$2,217,634,994	$1,551,816,138	42.9
Other products, and receipts for repairing	$68,638,048	$85,490,897	−19.7
Value added by manufacture[3]	$1,365,082,079	$991,545,336	37.7

[1] Not including salaried employees. The average number of wage earners is based on the numbers reported for the several months of the year. Because of the fact that manufacturers report the numbers employed on or about the 15th day of each month, as shown by the pay rolls, usually taking no account of the possibility that some or all of the wage earners may have been on part time or for some other reason may not actually have worked the entire month, this average somewhat exceeds the number that would have been required for the work performed if all had been continuously employed throughout the year. Thus in some cases the number reported for a given month exceeds the average for that month.

[2] Manufacturers' profits cannot be calculated from the census figures because no data are collected for certain expense items, such as interest on investment, rent, depreciation, taxes, insurance, and advertising.

[3] Value of products less cost of materials, containers for products, fuel, and purchased electric current.

TABLE II—ELECTRICAL APPARATUS, AND SUPPLIES PRODUCTION, BY CLASS AND VALUE: 1929 AND 1927

Class	1929	1927
Electrical machinery, apparatus, and supplies, all industries:		
Aggregate value	$2,323,597,927	$1,668,104,965
Made in the "Electrical machinery, apparatus and supplies" industry	$2,217,634,994	$1,551,816,138
Made as secondary products in other industries	105,962,933	116,288,827
Batteries, battery parts, and supplies	$145,207,574	*$146,693,521
Conduits and fittings	46,915,073	42,132,036
Control apparatus	42,451,032	*30,783,452
Fans, electric (including motors)	11,560,642	10,755,001
Electrotherapeutic and electromedical (including dental) apparatus	19,957,011	16,149,405
Fuses	10,784,689	8,811,050
Fuse blocks	2,635,596	2,080,192
Generating apparatus and parts	68,131,815	*104,246,026
Ignition apparatus for internal-combustion engines	54,426,944	35,123,296
Industrial, commercial, and domestic apparatus and appliances:		
Industrial and commercial	23,808,290	12,761,010
Domestic (household)	76,890,453	77,519,218
Instruments—measuring, relays, and instrument transformers	38,328,070	34,133,212
Lamps, incandescent-filament (not including sockets and other fittings)	85,319,515	87,933,244
Motors, except fan motors (not including starters or controllers)	185,233,201	*111,819,855
Switchboards, circuit breakers, and switches	79,424,219	71,924,341
Transformers, induction voltage regulators, and current-limiting reactors (except radio and measuring-instrument transformers)	78,114,532	*66,266,216
Insulated wire and cable	296,858,831	210,047,947
Wiring devices	43,120,093	32,703,331
Miscellaneous	936,059,847	578,350,676

*Revised.

Winter Convention To Be Reported Upon

As this issue of ELECTRICAL ENGINEERING goes to press, the major technical meeting of the Institute, the winter convention, is assembling in the Engineering Societies Building at 33 West 39th Street, New York. Early registrations presage a heavy attendance and indicate a wide general interest in the fifty papers to be presented at ten technical sessions.

In the March issue ELECTRICAL ENGINEERING will present a news story covering the principal features of the gathering. If discussors of papers presented cooperate sufficiently promptly, there also will appear in that issue a resume of important discussions; otherwise they will appear in a subsequent issue.

◆

Another Welding Essay Prize Contest Announced

For the purpose of increasing "the knowledge of the adaptability of arc welding to industry more especially of the adaptability of welding in the redesign of present machinery cast-iron or riveted steel structures to welded steel structures" the Lincoln Electric Company of Lincoln, Ohio, has announced its second arc welding prize competition. A total of $17,500 in prizes is offered, divided as follows:

First-Prize Paper	$7,500
Second-Prize Paper	3,500
Third-Prize Paper	1,500
Fourth-Prize Paper	750
Fifth-Prize Paper	500
Sixth-Prize Paper	250
Seventh to Forty-First Prize Papers	100

According to the announcement any person or group of two or more persons in any country of the world may submit a paper in this competition. However, mandatory requirements listed by the Lincoln Company include: (1) Only one paper from any competitor or group; (2) debarment of all Lincoln Company employees; (3) actual participation by each contributor in the work that forms the subject matter of his paper; (4) that descriptions be practical and readily understandable; (5) the machine or structure described must actually have been designed; (6) subject and illustrative matter must be in the English language; and (7) manuscripts must be mailed prior to October 1, 1931, arriving in Cleveland on or before October 31, 1931.

It is stated also that the subject matter of a paper submitted in the prize contest must come under one of the two following headings:

> "(A) A description of a useful machine, structure, or building previously made in some

other way that has been redesigned in whole or in part, so that arc welding is applied to its manufacture.

(B) A description of a machine, structure, or building not previously made that has been designed in whole or in part to the use of arc welding and a description showing how a useful result is obtained which was impractical by means of other methods of manufacture. It is not necessary that the machine as redesigned should have been manufactured at the time of writing the paper."

Details and further information are available from the Lincoln Electric Company, P. O. Box 683, Cleveland, Ohio.

◆

American-Scandinavian Fellowships Due for Consideration

In April, 1931, the American-Scandinavian Foundation will award to students of American birth a number of traveling fellowships for study in Scandinavian countries during the academic year 1931-1932, each fellowship to carry with it a salary of $1,000.

Graduate students and younger instructors and professors in American colleges are especially urged to become candidates; and it is preferred that all applications first be considered by their suitable college or university authorities.

Chairman of the final jury of award is Professor William Hovgaard of M. I. T. and as the meeting of the jury takes place in April, it is of importance that all nominations be well in hand by March 1st.

Send for details to Neilson Abeel, Secretary to the Foundation, 25 West Forty-Fifth Street, New York, N. Y. He will gladly supply application blanks and full information as to course of further procedure.

◆

Lehigh University Announces Fellowships

Up to April 1st, C. R. Richards, president of Lehigh University will receive applications for fellowships in Lehigh's Institute of Research, as follows:

One: Henry Marison Byllesby Research Fellowship in any branch of science or technology dealing with technical problems of interest to the public utilities.

One: James Ward Packard Research Fellowship in electrical or mechanical engineering.

One: C. Kemble Baldwin Research Fellowship in any branch of science having a direct bearing on aeronautical engineering.

Two or more: Institute of Research Fellowships.

Stipends for these several fellowships will be $750 for the Byllesby, Baldwin, and Packard and $600 for the Institute of Research Fellowship, for each ten-month period, with freedom from tuition fees.

Applicants are requested to present full statement of training and experience; also a transcript of academic record, list of references, and a recent photograph.

◆

Yale Again Offers The Sterling Fellowships

Fellowships established by a gift of one million dollars from the trustees of the estate of the late John W. Sterling are offered again by Yale University, open to its own graduates and graduates of other approved universities and colleges in the United States and foreign countries, be they men or women professors or, instructors on leave of absence who wish to pursue studies and investigations under the direction of the faculty of the Graduate School at Yale or in affiliation with that body.

Stipends of the Fellowships range from $1,000 to $2,500 and more, dependent upon previous experience of the recipient and the character of the proposed investigation.

Applications must be submitted by March 1, 1931, addressed to Edgar S. Furniss, Dean of the Graduate School of Yale University, New Haven, Connecticut, upon blanks which may be obtained from him.

◆

Columbia University Offers E. E. Scholarships

Each year the governing bodies of Columbia University have placed at the disposal of the Institute a scholarship in Electrical Engineering in the School of Mines, Engineering, and Chemistry of Columbia University, for each class. The scholarship pays $350 toward the annual tuition fees which vary from $340 to $360, according to the details of the course selected. Reappointment of a student to the scholarship for the completion of his course is conditioned upon the maintenance of good standing in his work.

Applicants must meet the regular admission requirements, and all letters of application addressed to F. L. Hutchinson, the National Secretary, A. I. E. E., 33 West 39th St., New York, N. Y., should give age of candidate, place of birth, education, references, photograph, and reference to any other activities, such as athletics or working one's way through college. The last day for filing applications for the year 1931-32 will be June 1, 1931.

The course at the Columbia School of Mines, Engineering, and Chemistry is a three-year course on a graduate basis. Candidates must have had a general education, including considerable work in mathematics, physics, and chemistry. Three years of preparatory work with special attention to the three preparatory subjects mentioned in a good college or scientific school should be sufficient. A college graduate with a B. S. degree in engineering can generally qualify to advantage. The candidate is admitted on the basis of his previous collegiate record without undergoing special examination. Other qualifications being equal, members of Student Branches of the A. I. E. E. will be given preference.

The purpose of this advanced course is to produce a high type of engineer, trained in the humanities as well as in the fundamentals of his profession. It is hoped that Enrolled Students and others qualified will show a keen interest in this scholarship.

◆

Subway Noise Given Technical Attention

In the January issue of Electrical Engineering appeared a few of the facts on "Noise Measurement" as recently placed before the Middle Eastern District Meeting at Philadelphia, by John C. Steinberg, telephone quality engineer for the Bell Telephone Laboratories.

Offering encouragement to Mr. Steinberg's efforts there has now been appointed by the Board of Transportation of the City of New York, a group of acoustical engineers to make technical study of noises resulting from elevated and subway traffic, and to return a report upon applications possible to limit or eliminate these noises.

G. T. Stanton, acoustic consulting superintendent of Electrical Research Products, Inc., and an Associate of the Institute, has been given charge of these investigations and is carrying on tests to discover the exact causes of these noises and just where their volume is greatest. A test trip to the Battery reported in the daily press seemed to demonstrate that without a doubt the acceleration of motors is directly responsible for the greatest amount of noise emanating from any single source. Except in instances where one train was passing another, the highest level of noise was *inside* of the cars and not outside upon the tracks as most riders would suppose, the bulk of the noise appearing to be attributable to the grinding of gears, motors, and wheels beneath the car floor. With no ready escape in this region, the noises reverberate within the car causing a greatly increased volume of sound.

St. Lawrence Commission Wants Immediate Action

The immediate creation of a public "Power Authority" for the International Section of the St. Lawrence River development has been recommended to Governor Roosevelt and the New York Legislature by the Saint Lawrence Power Development Commission of which Robert M. Haig is chairman.

An engineering report has been made covering the project, and to quote the commission, "it has been found entirely practicable to construct the necessary project . . . utilizing existing transmission and distribution systems . . . under contract with operating companies to assure them fair remuneration for their services and assure to the consumer the advantages of low-cost power . . . Terms of such contract to be worked out upon basis of actual cost for generating, transmitting and distributing power.

"It is estimated that by 1937 the total generation of power in New York State will exceed 20,000,000,000 kw-hr. as compared with 13,000,000,000 kw-hr. in 1929."

Departing from many plans previously offered by Canadian and American engineering groups, the Commission recommends a one-dam, two-step development at Messena Point, New York—farther down stream than priorly considered, which it contends will "reduce construction costs, construction time, produce more power with the flooding of a minimum acreage and make for the elimination of the more serious hazard of building power house and spillway on what is now dry land."

By the New York press, the whole situation appears to be looked upon as largely a political development.

◆

The Midwest Power Conference Meets at Chicago in February

In view of the existing economic conditions and the relation between business economics and the power industry, what promises to be the most significant conference on power machinery for years will be held in Chicago February 10-14, inclusive, when nationally recognized authorities on power will address the Fifth Midwest Power Engineering Conference, and the Fourth National Fuels Meeting of the American Society of Mechanical Engineers at the Stevens Hotel.

Simultaneously, the Midwest Engineering Exposition will present at the Coliseum a "cross-section" of the newest developments in power machinery and appliances: G. E. Pfisterer, who is managing director of the exposition, reports that a realization of the absolute necessity of revaluating the many factors in power economics to meet both present and future conditions has created an unusually keen interest in this forthcoming event, which will not only present important possibilities to the experienced engineers but will also offer to young engineers the opportunity in a common meeting place for an interchange of views, the forming of contracts, and assimilation of the latest developments in the field of engineering.

Upward of 200 leading manufacturers of power machinery and appliances have engaged display space and all arrows seem to point to a full occupancy of the 85,000 square feet available at the Coliseum. Unusual exhibits of heating, ventilating and refrigerating machinery, demonstrating the gains which have been made in these various branches and further development along new lines, seems assured. The refrigerating industry, especially, is in a state of flux and the newer methods and appliances which will be displayed at this exhibition should be of intense interest.

Another important field will be that of generation, utilization and distribution of power, covering as it does the entire range of the power industry. Engineers will be able to study their specific problems, as many of the demonstrations will be by actual operation.

◆

Shall Advertising Menace Radio Programs?

That the real usefulness and benefit of radio program possibility is being materially hampered if not actually jeopardized by a superabundance of the commercial advertising element was stressed by Doctor Lee de Forest, retiring president of the Institute of Radio Engineers in his farewell address on the evening of January 6th. Doctor de Forest is quoted as having asserted that the present "state of affairs is an unhealthy one and gives alarming symptoms for the future . . . that advertising from the local stations has become so uncontrolled that one wonders at the patience of a suffering public."

Just what may be done to reduce or eliminate this so-called "cancerous growth" remains for the future to discover; it would appear that much of the sales talk and cheap mediocrity of advertising program selections now being broadcast might well be dispensed with and result in very real benefit to public listeners.

◆ ◆ ◆

Aircraft Radio Development Continues

FAIRCHILD 71-A monoplane acquired recently by the Bell Telephone Laboratories, New York, for further practical experimentation in two-way radio communication between planes and between planes and ground stations. Long- and short-wave equipment is installed, powered by a small dynamotor in conjunction with a storage battery.

That police officers patrolling a city from the air may actually be in closer touch with headquarters than the patrolman on the street was demonstrated in a recent practical experiment. Officials in this plane, officials in the laboratories' Ford plane, and officials in the New York police commissioner's office were participants in two-way and three-way communication between the planes and between the planes and ground, while the two planes were aloft over two widely separated parts of the city.

Some of the possibilities immediately suggesting themselves include the pursuit of criminals operating in high-powered automobiles, the untangling of highway traffic jams, and cooperation with fire departments in large water-front or industrial fires.

New Recommendations for Electricity on Shipboard

A 1930 edition of "Recommended practise for Electrical Installations on Shipboard" has just become available. The pamphlet, which was originally known as "Marine Rules" has been developed under the auspices of the A. I. E. E. committee on application to marine work and in its new edition includes extensive revision of the 1927 issue, with considerable of new material on such points as motor-operated, water-tight doors, electric brakes, radio compasses, etc. It is known as Section 45 in the Institute's Standards series, and is on sale at a price of $1.50 per copy with a 50 per cent discount to Institute members.

◆

A $5,000 X-Ray Screw Driver

According to recent press reports from Stanford University (California) the versatile X-ray has been harnessed to the lowly task of driving screws.

It is said that P. A. Ross, the inventor, physics professor at Stanford, uses his machine as demonstrable support for the theory that X-rays behave like bullets rather than like waves, as is popularly believed. His equipment consists principally of an X-ray spectrometer. Indications are that the new device will not, however, at once displace the ordinary household tool, for it admittedly requires a lot of screw-driving to warrant a $5,000 implement. But it is stimulating, to allow free rein to the imagination in considering some of the many possibilities of little-known forces.

◆

East River Tube Projected for New York

It is reported that the War Department at Washington already has approved proposed construction of $50,000,000 twin vehicular tunnels under the East River, New York, the city being committed to the project by an appropriation of $350,000 for borings, engineering studies, and estimates. Actual report by the city's Board of Transportation has not yet been forthcoming, and John H. Delaney, chairman is quoted as having stated that "recommendations would probably be made within the next three months."

The tubes would connect Borden Avenue, Queens, with East 37th and 38th Streets, Manhattan, and would form the eastern third of a vehicular channel proposed for fast middle-Manhattan crosstown traffic, ultimately to cross Manhattan underground to the Hudson River and thence to Weehawken, N. J., via another bore. Preliminary investigations have been completed, and the issue awaited now seems to be an economic one to prove or disprove its feasibility.

◆

Nearly 14 Million Miles Phone Wire in New York City Area

New York City is served by 9,400,000 mi. of telephone wire, about 495,000 mi. of which was installed during 1930, according to a review for the year issued today by J. S. McCulloh, president of the New York Telephone Company. Manhattan alone has a total of 3,734,000 mi. of wire, of which 254,000 were added during the year.

More than 98 per cent. of all telephone wire mileage is now enclosed in stormproof cable, the report shows. Twenty new central offices, including nine in New York City, installed in 1930 bring the total in service in the company's territory to 494. The wire mileage interconnecting the telephones served by the company was increased in 1930 by 948,000 to a present total of 13,750,000 mi.

◆

Vestal Copyright Bill Recommended

Edwin J. Prindle, chairman of the Pentent Committee, has recommended that the American Engineering Council endorse the Vestal Copyright Bill, H. R. 12549. This House bill provides (1) for automatic copyright, (2) that the author may divide such copyright into separate ways in which it is capable of utilization, (3) that all authors, be they American or foreign, will have automatic copyright in all countries which are members of the International Copyright Union, (4) that the term of copyright will be for the life of the author and fifty years after his death, and (5) that prints and labels for articles of manufacture are included in said copyright.

◆

Japanese Professor Arrives for Study of Electronics

Masaharu Hoshiai, assistant professor of electrical engineering at Tokyo Imperial University is now in New York, having been sent to America for a year's stay by the Denki-Gakkwai—the Institute of Electrical Engineers of Japan—under a grant from the Iwadare Fund for the encouragement of electrical science. Professor Hoshiai is the first person selected under this endowment.

Professor Hoshiai was graduated from the electrical engineering course of the Imperial University in 1922 and has since devoted his time to the study and teaching of electrical science at that University. The purpose of his visit is to extend his knowledge of applied electronics. Mail can be addressed to him in care of W. H. Capen, International Standard Electric Corporation, 67 Broad Street, New York City.

◆

Civil Engineers Elect Francis Lee Stuart

The opening session of its Wednesday morning meeting, January 21, saw the installation of Francis Lee Stuart, consulting engineer for the City of New York, as President of the American Society of Civil Engineers. As chief engineer of the Baltimore & Ohio Railroad from 1910 to 1915 and subsequently its consulting engineer, Mr. Stuart is of course well known in all railway and transportation circles. He has served also as chairman of the budget committee of the U. S. Railroad Administration in 1919 and in 1920 acted as consulting engineer to the Hydro-Electric Power Commission of Ontario (Canada).

In assuming his new office Mr. Stuart's message was directed toward the present critical situation facing business and industry and stressed the vital importance of the engineer's duty toward ultimate adjustment of financial, managerial, and economic complications through a better understanding of cause and effect.

Research and investigational activities of government bureaus in their importance to the engineering profession consumes the balance of Wednesday. In attendance at that meeting were George K. Burgess, director of the Bureau of Standards; J. D. Sears, administrative geologist of the United States Geological Survey; Major-General Lytle Brown, chief of U. S. Engineers, S. H. McCrory, and others of eminence.

The place of the civil engineer in the planning of cities, the prequalifications of highway contractors, and the use of natural gas for the generation of steam power, afforded no little food for debate. Thursday offered a full day for the discussion of these and several other interesting themes.

Friday closed the convention with excursions to New Jersey to inspect the recently constructed terminal of the Lackawanna Railroad, facilities of the

Newark airport and important highway and bridge construction now going forward under the direction of the New Jersey Highway Commission.

Social functions of the meeting included a dinner dance at the Roosevelt Hotel Wednesday evening, when Honorary Membership in the Society was conferred upon John R. Freeman, nationally known hydraulic engineer; and a smoker Thursday evening at which Doctor Roy Chapman Andrews told of his recent expedition to Central America. Approximately two thousand engineers from more remote sections of the country as well as those in proximity to the East attended and benefitted by the fellowship of the meeting.

◆

Television Again Demonstrated

Previous application of this marvel of science has been so restricted to test and experiment that the "running public" have quite "counted themselves out" as a matter of course. Now things seem to be getting along and on January 7th, a "television tea" was given by Bell Telephone Laboratories and the American Telephone and Telegraph Company, jointly, when one group of woman guests gathered at one location were called separately to the telephone to greet "in person" the several members of a group at the other location. Many of these guests were members of the Woman's Engineering Club, and the tea proved highly instructive as well as diversive.

In this same field the use of television is being debated as an adjunct to police forces, to supplement police radio broadcasting already in action. Pictures of fugitives from justice would appear across the television screen in station houses or police patrol cars and the police would be given an actual visual knowledge of the person or persons to be apprehended. Chicago already is pioneering in this tryout as to the feasibility of police television and the authorities there after witnessing a demonstration through the *Chicago Daily News* experimental television station have recommended the adoption of visual radio in direction against and detection of crime. Mr. Wade, president of the Western Television Corporation of Chicago, by whom the demonstration was made, explained that the police department could have its own television transmitting station with television receivers in each outlying station house and that the police cruising cars now equipped with short-wave receivers could have also television receivers.

N. Y. Electrical Association Elects New Officers

Clarence L. Law, Associate A. I. E. E., general commercial manager of the New York Edison Company, and assistant to the vice-president of the Yonkers Electric Light and Power Company, was elected yesterday to the presidency of the Electrical Association of New York at its annual meeting at its headquarters, 100 East Forty-fifth Street.

Mr. Law succeeds Earl Whitehorne, assistant vice-president of the McGraw-Hill Publishing Company. Others elected at the association's meeting were Theodore H. Joseph, first vice-president; A. Lincoln Bush, second vice-president; H. H. Barnes, jr., third vice-president; Frank A. Pattison, fourth vice-president; L. L. Strauss, treasurer; Edward Ingraham, secretary, and J. A. Corcoran, assistant secretary.

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San Antonio Now has High-Pressure Plant

What is said to be the highest-pressure steam-electric generating unit now in commercial operation recently was placed in operation by the San Antonio Public Service Company in its Conception Road station. There the company has rebuilt what is generally known as Station B, by adding an 8,000-kv-a. unit to the 12,500-kw. unit of the original layout.

The rebuilt plant now consists of a 20,000-kw. compound unit designed for a maximum of 1,400 lb. pressure with a temperature of 825 deg. fahr. at the throttle. The combined units operate in parallel connection to the busbars and the old unit now constitutes the low-pressure stage of the whole, with an operating pressure of 175 lb., 550 deg.

Another interesting feature of the rebuilt is that the new high-pressure boiler is installed in the already existing boiler room, with the roof raised to accommodate the new equipment; the air heater and economizer are located outside of the building.

Another advantage, especially in this locality, lies in the fact that although the unit is designed primarily for oil firing, a natural gas fuel may be used if desired. With the installation of turning gears, the adjacent larger units will now be used for standby purposes or to handle peak loads. The company's engineers are most enthusiastic over these gears and are endorsing their further application on other standby units of the system.

American Engineering Council

A. E. C. will Participate in Washington Celebration

By special invitation from the George Washington Bicentennial Commission, and a set of resolutions approved and adopted at its last board meeting, the American Engineering Council will participate in plans for the national celebration of the 200th anniversary of the birth of George Washington, America's first engineer president.

By these resolutions, a copy of which was transmitted to S. Bloom, director of the commission, and incorporated in the official proceedings of the meeting, the Council pledges its earnest cooperation with the commission in such ways as may open to further the completeness of plans for suitable observance of this memorial date.

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Engineers Aid Hoover's Employment Committee

As the outgrowth of a conference of representatives of architects, contractors, engineers, and the steel, cement, and lumber industries called by Col. Arthur Woods, chairman of President Hoover's emergency committee for employment, there has been formed a public and semi-public works section of that committee. The purpose of that section is to endeavor to ascertain why works projects already authorized and for which appropriations have been made are not going forward, discovering if possible ways and means of expediting them so that the work will be undertaken promptly.

General C. W. Kutz, Corps of Engineers, U. S. A., (retired) is serving as the American Engineering Council's representative in this work, and the American Society of Civil Engineers has requested its local sections to serve as the principal field agencies for collecting necessary information. Emergency bills passed by Congress have removed some inhibitions of existing law or regulations in so far as the federal work is concerned and there are other bills pending which, if passed, will remove other impediments.

The President's emergency committee also desires to collect through the American Engineering Council information regarding any efforts made by employers to stabilize employment during the present emergency and any permanent plans adopted. Sections of the Institute and the American Society of Mechanical Engineers were requested in December to undertake this task. Results of their surveys give much of the desired information regarding employment conditions in the various industrial centers and the efforts of local organizations to bring about improvements.

A pamphlet entitled "Outline of Industrial Policies and Practises in Time of Reduced Operation and Employment" has been prepared for the emergency committee, and copies may be secured by addressing the committee, Department of Commerce Building, Washington, D. C.

A. E. C. Officers Elected at Annual Meeting; Business Stabilization Plans are Discussed

C. E. GRUNSKY, re-elected president of the American Engineering Council, presided at its annual meeting held at the Mayflower Hotel in Washington, D. C., Jan. 16-17, 1931. Other officers elected for the coming year included O. H. Koch of Dallas, Texas, and D. Robert Yarnell of Philadelphia, as vice-presidents; H. E. Howe of Washington, treasurer (re-elected); and Lawrence W. Wallace of Washington, executive secretary (re-elected). The other two vice-presidents, who continue for another year, are Lewis Buckley Stillwell of New York and Gardner S. Williams of Ann Arbor, Mich.

Actions of importance to the nation, of interest to the engineering profession as a whole, and of particular interest to many individuals among the 59,000 professional engineers which it represents, were taken by the Council. These are outlined in the following paragraphs.

BUSINESS STABILIZATION

Seven principal points of attack on the problem of accomplishing business stabilization were recommended in a report prepared by a committee headed by Ralph E. Flanders of Springfield, Vt., vice-president of the American Society of Mechanical Engineers. The report recommended in part:

> (1) Maintaining or increasing the consumption of goods and services; (2) balancing plant, machinery and processes against production demands; (3) balancing distribution agencies against consumer requirements; (4) balancing manpower against production and distribution demands; (5) controlling money and credit to satisfy the needs of government, business, and the individual; (6) encouraging research activity to increase human well-being through development and progress in industry and business; balancing public works against public need.

The Council authorized its administrative board, and through it the executive committee, to take such steps as may be desirable to bring about such measures as the report recommends.

Further appropriations by the federal government to relieve the present depression were disapproved, and the proposal of a federal bond of 1,000 million dollars to construct public works was specifically opposed by the assembly, the legislative organ of the Council. Acting upon the recommendations of a committee headed by L. B. Stillwell of New York, the assembly opposed plans advocated by various organizations and individuals looking to the issuance by the federal government of large amounts of bonds for emergency construction work, on the grounds that:

> The organization and facilities of the several departments of the government, which under the law must direct this work, would not be able to expend with reasonable efficiency and within a period of two years any large amount in addition to the appropriations already made. Sums already made available by the federal, state, and municipal governments by the railroads, public utilities, and other corporations, are so large in the aggregate as to make the effect of an additional billion dollars which might be appropriated relatively of secondary or minor importance.

RECOMMENDATIONS ON FEDERAL PROJECTS

Establishment of a federal department of public works was urged by Major Gardner S. Williams, in his report as chairman of the committee on government reorganization. Major Williams stated the belief that the measure would not meet with as much opposition this time as previously experienced; and that it was becoming generally recognized that if such a department had been in existence for the past ten years or more a great deal of the present confusion in connection with the emergency construction of public works would have been avoided.

Opposition to all Muscle Shoals bills that contemplate government ownership or operation, or that set aside the intent and purpose of the Federal Water Power Act was reaffirmed by the Council.

A special committee appointed to study the McNary-Parker bills, which provide for the establishment and development of American transport services overseas, to encourage construction of American airships and other aircraft in the United States by American capital for use in foreign commerce and for other purposes, recommended that the Council support these bills in principle and allow the committee time for further study. The Council approved the recommendation.

The Council voted to use its influence to secure the appropriations necessary to the restoration of the locks in the Norfolk-Florida Canal.

Acting upon a carefully prepared recommendation of the Washington Society of Engineers, the Assembly voted:

> (1) That the Council strongly endorse the principle of the federal government paying all the necessary expenses of transporting civilian engineer employees, their dependents, and household effects, incurred by a change of station under competent orders. And since the executive committee of the interdepartmental board on simplified office procedure, office of the chief coordinator, now has under consideration a proposed act to provide for change-of-station allowances—
>
> (2) that a proper representative of the Council confer with the committee for the purpose of acquainting the committee with the Council's very keen interest in the matter, and with its desire to correct any inequities prevailing and to work with the committee to the end that any legislation it finally proposes will conform to the expressed desires of the Council.
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> (3) That the Washington Society of Engineers be asked to continue its special committee so that the Council may call upon it from time to time for information and advice as the work proceeds.

PRESIDENT GRUNSKY'S SUGGESTIONS

A special committee appointed to study the president's speech at the opening of this session of the Council, found three important suggestions in the president's address which should receive careful consideration. The first suggestion, concerning the minimum height of bridges over navigable waters, was referred to the Council's committee on bridges.

The committee recommended that L. W. Wallace, executive secretary of the Council, be requested to take up with the Society of Naval Architects the matter of the maximum size of merchant ships in relation to docks and canals, and if possible secure their advice and opinion.

The third suggestion, concerning the important question of the conservation of natural water resources, was referred to the Council's committee on water resources.

ACTION ON CONGRESSIONAL BILLS

The Assembly, at the recommendation of the Committee on Public Affairs, considered a number of bills now pending in Congress, and voted on the attitude of the Council in regard to them. The Assembly voted actively to oppose S.5209, S.4819, and S.4938,—three bills on the subject of road legislation. The Council will support H. R. 13576, another road bill, and bills S.4791 and S.5021 concerning federal building programs.

The subject of a new naval towing tank in Washington was considered by the Council, and the following resolution passed:

Whereas, the present naval towing tank in Washington, D. C., is inadequate for modern experimentation and not equal in size and other facilities to those maintained by the most modern and progressive nations, and

Whereas, the Navy Department is requesting an appropriation for the construction of a new naval towing tank along the Potomac in the vicinity of Cabin John Bridge, and

Whereas, the American Engineering Council has supported similar projects for the benefit of scientific research in other departments, as for example, the National Hydraulic Laboratory at the Bureau of Standards, and

Whereas, such an experimental model basin as proposed by the Navy would contribute incalculable values in keeping the United States in the forefront of naval construction and design,

Be it resolved, that the public affairs committee recommends that the American Engineering Council endorse this project and appoint a special committee to confer with the naval authorities and members of Congress and offer to these agencies any practical assistance in securing the enactment of legislation looking to the creation of a new model basin towing tank.

The Assembly acted favorably upon the application of the Colorado Engineering Council, Denver, for membership in the American Engineering Council, and welcomed their representative, R. C. Gowdy, chief engineer of the Colorado and Southern Railway Company. Appointment of a representative on a joint committee to study prequalifications for contractors was authorized, but the Assembly declined to express its opinion at this time as to the advisability of such prequalifications.

Representatives of the American Institute of Electrical Engineers in attendance were A. W. Berresford, C. O. Bickelhaupt, F. J. Chesterman, M. M. Fowler, F. L. Hutchinson, W. S. Lee, William McClellan, L. F. Morehouse, I. E. Moultrop, Farley Osgood, W. S. Rodman, R. F. Schuchardt, Charles F. Scott, C. E. Skinner, Harold B. Smith and L. B. Stillwell.

Personal

LEE DE FOREST, retiring president of the Institute of Radio Engineers, and Fellow of the A. I. E. E., was born at Council Bluffs, Iowa. In 1896 he was graduated from Sheffield Scientific School of Yale University with the degree of B. S.; in 1899 he received his Ph. D., and in 1926 D. Sc., both from Yale. He has been identified with radio since the year 1901; in 1906 he patented the audion or three-element vacuum tube, and in the years that followed became an active worker in its various applications. Doctor de Forest has been the recipient of many honors, among them the Gold Medal of the St. Louis Exposition in 1904 for work on wireless telegraphy, the Gold Medal of the San Francisco Exposition in 1915 for his work in radiotelephony; the cross of the Legion of Honor from France; the Elliott Cresson Medal from the Franklin Institute; the Medal of Honor from the Institute of Radio Engineers, and the John Scott Medal from the City of Philadelphia.

LEE DE FOREST

Doctor de Forest assumed the presidency of the I. R. E. January 1930.

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RAY H. MANSON, a member of the Board of Direction of the Institute of Radio Engineers (1928), and a member of the A. I. E. E. since 1902, has been chosen president of the radio engineers, taking office at the recent January meeting.

He was born at Bath, Maine, was graduated from the University of Maine in 1898, and received his degree of E. E. from that institution in 1921. From 1899 to 1900 he was employed in the telephone manufacturing department and the electrical laboratory of the Western Electric Company in Chicago; the next four years were spent in the engineering and sales departments of the Kellogg Switchboard and Supply Company, Chicago. Then for a long period—until 1916—he was connected with the Dean Electric Company and its successor, the Garford Manufacturing Company of Elyria, Ohio, where for the last four years his service was as chief engineer. Since that date he has been busy with the Stromberg Carlson Telephone Company, Rochester, and is now its chief engineer and one of its vice-presidents.

During his affiliation with the manufacturing business, he has taken out over fifty patents on inventions in telephone, phonograph, and radio fields. He has been active also in radio standardization work in the radio division of the National Electric Light Association and is now chairman of its technical committee; for several years, he has been serving also as chairman of the electro-acoustic subcommittee of the I. R. E.

RAY H. MANSON

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ROBERT LEE WILSON, Fellow A. I. E. E and assistant to the president of the Westinghouse Electric and Manufacturing Company has resigned from that position. Mr. Wilson's resignation became effective December 31, 1930. While he will devote himself mainly to his private affairs, he will be retained by the Westinghouse Company on call in a consultative capacity, according to the statement made by F. A. Merrick, president of the company, in accepting the resignation.

In 37 years of service with Westinghouse Mr. Wilson rose from apprentice to draftsman, to inspector, road engineer, district engineer, superintendent of construction, superintendent of railway construction, assistant general superintendent, works manager, and then assistant to the president.

Born in Shelbyville, Ill., January 29, 1871, he was the son of Dr. William G. and Frances Anna (Lee) Wilson, who had moved to Illinois from Hartford county, Maryland. Mr. Wilson received his preliminary education in the public schools of Shelbyville, attended the University of Iowa for one year and Rose Polytechnic Institute, Terre Haute, Ind. for three years, graduating from the latter institution with the degree of bachelor of science in mechanical engineering in 1892. He took one year of post graduate work in electrical engineering at Johns Hopkins and started work for Westinghouse in 1894. He married Fanny Hampton Jeffers Kennard of Pittsburgh in 1900.

From 1903 to 1905, while he was district engineer with headquarters in New York, Mr. Wilson superintended the original electrification of the elevated and subway lines. While he was superintendent of railway construction from 1906 to 1909, he handled the biggest job ever undertaken by Westinghouse, the construction and installation of equipment for the electrification of the New York, New Haven and Hartford railway and the St. Clair tunnel of the Grand Trunk railroad. Much reconstruction work was necessary on these contracts; they were the first two important a-c. railroad electrification projects in the United States.

Mr. Wilson was one of the first industrial leaders to advocate elective representation in works councils and the amicable adjustment of disputes by joint conference committees representing management and employes. Recognition of his fairness and his service in employment and welfare work has come from all divisions of the Westinghouse organization. He was elected a member of the board of directors of the Westinghouse Veteran Employes' Association and has also been very active in other shop organizations.

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T. S. Perkins, formerly manager of supply engineering and consulting engineer for Westinghouse Electric & Manufacturing Company, has with the first of the year become its general manager of distribution engineering and will represent S. M. Kintner, assistant vice-president, in his work with several departments. Already Mr. Perkins has done much creditable work in his solution of complicated problems in the supply engineering department and standardization of production and design. R. W. Owens becomes general manager of industrial engineering and will represent Mr. Kintner in another group of the Westinghouse departments; most of his work has been in connection with motor engineering and he now falls into the field of the supervision of industrial motors, control, small motors and industrial heating engineering. At the Sharon works, W. M. McConahey has been appointed consulting engineer with headquarters in the transformer department, H. V. Putnam to succeed him as manager of the transformer engineering department. Other important changes effective January 1, 1931, are the appointment of M. S. Hancock as assistant manager of of the industrial motor engineering department and R. E. Marbury as assistant manager of the supply engineering department.

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W. S. Conlon has been named as successor to J. C. Williams, city engineer for Stamford, Connecticut. His varying work in the past as executive engineer, consulting engineer, designing and construction engineer, superintendent of construction and assistant engineer and assistant superintendent of construction of buildings, docks, sewage systems, water supply, etc., should make Mr. Conlon particularly well fitted for this new public works undertaking, especially as most of the past operations have been with engineering surveys and investigations in studies and reports for public utilities, railroads, etc., such as the New York subway and elevated service, the New England Power system in Vermont, New Hampshire, Rhode Island, Connecticut and Massachusetts, and other similarly representative organizations.

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H. O. Stephens, I. H. Sclater and A. B. Hendricks, Jr., have been appointed assistant engineers of the power transformer department of the General Electric Company, Pittsfield, Massachusetts, of which F. F. Brand is managing engineer. Mr. Stephens will be in charge of the design of oil-immersed transformers over 7,000-kv-a., air-blast transformers, reactors, and starting auto-transformers; Mr. Sclater will have charge of transformers from 501- to 7,000-kv-a., oil-immersed current and potential transformers, radio power, and other transformers; while the design of all developmental and high-voltage testing apparatus will come under the direct charge of Mr. Henricks.

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G. H. Cole on January 1 was transferred from the executive division of the American Rolling Mill Company, Middletown, Ohio, to become associate director of its research division. Extensive experience in the engineering and research work as well as his earlier service in the executive division of ARMCO will aid Mr. Cole greatly no doubt in his new field of service.

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Roy Page, who is vice-president and general manager of the Nebraska Power Company, Omaha, Nebraska, where he has always been active in civic affairs, was elected to the board of directors of the United States National Bank at its recent annual meeting. The United States National Bank is associated with the Northwestern Bancorporation.

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Louis Mackler, formerly electrical engineer with L. T. M. Ralston, Inc., New York City, has been appointed consulting engineer to the P. F. O'Keefe Advertising Agency, Inc. which has offices in Boston and New York. Mr. Mackler will remain in New York.

Obituary

Edward G. Connette, president of the United Gas & Electric Corp., and an expert in field utilities, died at Lockport, New York, December 30, 1930. Mr. Connette was a native of Austin, Indiana.

In his active career he started as telegraph operator in the mechanical and engineering departments of steam railroads where he shortly became assistant superintendent. In 1889 he took charge of street railway operations in Nashville, Tenn, and as superintendent equipped them with electric apparatus including the first double-reduction type of motors. After one year he was made general manager, at the same time serving as general manager and chief engineer of the Cumberland Electric Light & Power Company, Nashville, Tenn. His next service was as vice-president and general manager of the Syracuse Rapid Transit Railway Company, from which in 1905 he transferred to general managership of Worcester Consolidated Street Railway and subsidiary companies. This in 1909 led to his choice as transportation engineer for the public service commission's First District; there, besides being in full charge of the transit bureau, he supervised equipment of the inspection bureau (including power houses, transmission lines, cars, etc.) the accident bureau and appraisal bureau. Recently he had been associated with the J. G. White Management Company of New York City; he had served also as vice-president of the Wilkes-Barre Company, president of the United Gas and Electric Corporation, the Harrisburg Light Corporation Company, the Elmira Railway and Light Company and the Lockport Light and Gas Company, which latter he was visiting at the time of his death. For five years he was vice-president of the Syracuse Rapid Transit Railway Company, and for two years vice-president of the International Railway Company at Buffalo, New York, and afterward its president. He had served also as director and member of the executive committee of his company and vice-president, director and member of the executive committee of the International Traction Company. His club connections included the Municipal Engineers, the Buffalo Club, the Old Ellicott Club, the Wanakah Club, and the Country Club of Buffalo.

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Eugene A. Hart, a popular and active member of the Institute's Los Angeles Section, and manager of the transmission department of the General Electric Supply Corporation, Los Angeles, died at his home in that city December 11 after an extended illness of several months.

He was born at High Point, Missouri, April 1881 and after completing high school took special courses in electrical engineering. In 1896 he started an apprenticeship with the Los Angeles Electric Company which kept him busy until 1904; then he removed to Chicago to pursue his electrical bent in the meter department of the Commonwealth Electric Company. His general duties from 1904 to 1913 were in connection with small combination gas and electric plants of the Jefferson City (Mo.) Light Heat and Power Company; when he resigned he had advanced to the office of assistant manager. He then spent 3 years in electrical contracting, after which he became assistant manager of the Missouri Public Utilities Company at Poplar Bluff. This led to a managership of the company's operations in what was known as the Lead Belt Group, at Flat River, Mo., where he built the distribution systems and transmission lines for seven towns.

In 1917, he was transferred to become manager of its southeast Missouri group (13 towns) with headquarters at Cape Girardean, Mo., work involving a combination of water, gas, electric, and street railway properties, rebuilding all departments including 160 miles of power lines. The Los Angeles Gas and Electric Company induced him to enter its distribution department in 1924. From 1925 to 1927 he was sales engineer in charge of the transmission department of the Los Angeles district of the Pacific States electric Company, predecessor of the General Electric Supply Corporation.

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Samuel Winthrop Dean, Associate of the Institute, died January 8, 1931, in the Massachusetts General Hospital, Boston, after a long illness.

Mr. Dean was born August 29, 1897, at Cambridge, Mass. During the war he served as Ensign in the U. S. Naval Reserve Force. After graduation with A. B. degree from Harvard University in 1919, he was employed with the Radio Corporation of America until 1925, working on transmitting and receiving radiotelegraph problems. From 1925 until his illness he was with the development and research department of the American Telephone and Telegraph Company engaged in development of long-wave receiving systems for transatlantic radiotelephony. During this period Mr. Dean spent some time in England and Scotland. He was the author of several technical papers and was granted several patents.

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G. Stanley Covey, assistant service foreman of The Washington Water Power Company, Spokane, Washington, and an Associate of the Institute, died in December 1930. He was born in March 1878 at Jordan Falls, Shelburne County, Nova Scotia, and after attending both high school and private school took a special course in steam engineering. Later he spent three years in the operating department of the Pacific Electric Railway Company, Los Angeles, and one year as an engineer for the Southern California Edison Company at San Bernardino. He had been with the Washington Water Power ever since 1904, where his first services was principally on the operation of motors.

◆

Huibert Doyer, a Member for Life of the Institute and for many years a resident of Clos Myriel Chaillyvillage, Lausanne, Switzerland, recently died suddenly at his home. Mr. Doyer was born in Utrecht in 1862, and was a charter member of the Institute. He was graduated from the Holland Polytechnical School in Mechanical Engineering in 1885 and for sometime thereafter worked in the physical laboratory of that institution, in an ambition to promote so far as possible the electrical industry in Holland. He became internationally prominent, and now leaves behind him a host of friends, both in the profession and in civil life.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the Secretary at 33 West 39th St., New York, N. Y.

All members are urged to notify Institute Headquarters promptly of any changes in mailing or business address, thus relieving the member of needless annoyance and assuming prompt delivery of Institute mail, the accuracy of our mailing records, and the elimination of unnecessary expense for postage and clerical work:

Bradford, A. O., Central Mex. Lt. & Pr. Co., San Luis Potosi, S. L. P., Mex.
Cromwell, P. C., Arthur Anderson & Co., 1814 Harris Trust Bldg., Chicago, Ill.
Davis, R. H., Westinghouse E. & M. Co., East Pittsburgh, Pa.
Dawson, Leonard L., 98 Looker Ave., Springfield, N. J.
Gale, R. E., 706 N. 19th St., Boise, Idaho
Herrera, R., Utah Pr. & Lt. Co., c/o Mr. Bennion, Salt Lake City, Utah
Kigar, D. F., 1403 Minnie St., Port Huron, Mich.
Lieb, Adolph W., N. Y. Edison Co., 393 7th Ave., New York, N. Y.
Mahnke, E. Chris, 1400 E. 53rd St., Chicago, Ill.
Prehn, Victor N., 940 Broad St., Newark, N. J.
Sherwood, W. E., Kew Gardens, 2700 Que St. N. W., Washington, D. C.
Sliney, David, 11 Orchard St., Cranford, N. J.
Vav Wyck, P. V. R., Summit, N. J.
Vreeland, F. P., 110 E. 176th St., New York, N. Y.
Williams, Clifton S., Research Lab., Westinghouse E. & M. Co., East Pittsburgh, Pa.

Local Meetings

New York Power Group to Meet Next in Newark

The Power Group of the Institute's New York Section will hold its next meeting in the Public Service Auditorium, 80 Park Place, Newark, New Jersey, the evening of Tuesday, February 17th, at 7:30 o'clock, with R. E. Powers of the Westinghouse Electric & Manufacturing Company as the speaker.

Mr. Powers takes for his subject "High-Speed Relaying and Switching," and will devote his time principally to showing how the margin of stability can be increased by increasing the speed of fault removal, as well as by speeding up the action of relays and circuit breakers. A general discussion in which all present should freely participate will follow Mr. Power's talk.

The nomination of Power Group officers for 1931-32 also will be considered at this meeting.

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Color in the Work World

On the evening of Tuesday, February 10th, the New York Section jointly with the A. S. M. E., the New York Electrical Society, and the Museum of Science and Industry, will hold a meeting on "Color in the Work World."

Chiefly, this will be a demonstration lecture by Doctor M. Luckiesh, director of the lighting research laboratory of the General Electric Company. Doctor Luckiesh, who has been making an exhaustive study of color and its effects upon the various processes of industry and occupational surroundings, is ably prepared to present his conclusions in a particularly interesting manner.

The meeting will be held in the auditorium of the Engineering Societies Building, 33 West 39th Street, New York, at 8:15 o'clock; because of the popular nature of the topic of the evening, admission will be by ticket only, but reservation forms will accompany the regular meeting notices sent out to the membership.

Future Section Meetings

Cleveland

February 19, 1931—Recent Progress in Communication Technology. Speaker from the Bell Telephone Laboratories, Inc., to be announced later.

March 19, 1931—Industrial Applications of Vacuum Tubes and Photo-Electric Cells, by E. L. Manning, General Electric Research Laboratories, Schenectady, N. Y.

Detroit-Ann Arbor

February 17, 1931—Detroit Toll Board, by E. C. Balch, Michigan Bell Telephone Co. Meeting at Michigan Bell Telephone Auditorium.

March 17, 1931—The Sound of a Shadow, by J. B. Taylor, General Electric Co.

Niagara Frontier

February 16, 1931—Air Circuit Breakers, by Mr. Gunion, I. T. E. Co.

March 20, 1931—Subject and speaker to be announced later.

Seattle

February 17, 1931—Operating Problems of Trunk Line Electrification, by J. Hawe, Electrical Engineer, Great Northern Railway.

March 17, 1931—Annual joint meeting of the Founders' Societies with program in charge of the American Society of Civil Engineers.

Sharon

February 3, 1931—Audible Light, by John B. Taylor, General Electric Co.

Spokane

March 27, 1931—Program by local members as follows: Service and Services, by G. S. Covey; Standard Meter Equipment, by J. G. Finley; Relay Application to Feeder Protection, by C. F. Norberg.

Past Section Meetings

Akron

Power Transformer Design and Tap Changing Under Load, by L. C. Nichols, Allis-Chalmers Mfg. Co. Film—"The Story of Bakelite Resinoid" presented. December 11. Attendance 70.

Baltimore

Recent Engineering Projects by the Bureau of Mechanical Service, by Warren Viessman, Mechanical-Electrical Engineer, City of Baltimore. Illustrated with views of the city's engineering developments in street lighting, airport illumination, power conduits owned by the city, city incineration, and power installations in various city buildings.

Water Works Pumpage—The Vernon Pumping Station, by Leon Small, Superintendent Engineering Division, City of Baltimore. Joint meeting with the A. S. M. E., A. S. C. E., and Baltimore Engineers Club. December 12. Attendance 58.

Boston

Recent International Understandings in Electrical Engineering and Radio, by Dr. A. E. Kennelly, Harvard University. December 9. Attendance 75.

Columbus

Chain Broadcasting and Teletype Operation, by J. T. Jenkins, American Tel. & Tel. Co. Accompanied by demonstrations of some apparatus used in teletype work. December 5. Attendance 65.

The Threshold of a New Era in Lighting, by T. P. Brown, Edison Lamp Works. Illustrated. January 9. Attendance 25.

Connecticut

High-Pressure Steam, by I. E. Moultrop, Edison Electric Illuminating Co. of Boston, and Vice-President District No. 1, A. I. E. E.;

Operating Results of the Mercury Turbine, by T. H. Soren, Hartford Electric Light Co. Meeting held at Hartford Electric Light Co., preceded by dinner at the City Club. December 15. Attendance 95.

Dallas

Meeting held under the auspices of the Student Branch at Southern Methodist University, at which the following papers were presented by Students:

Demonstration of Short-Wave Broadcasting, by D. J. Tucker;

Thermocouples, by R. L. Allen, Jr.;

Experiments with the Transformer, by Carlos Burnet. November 17. Attendance 75.

Annual Dance. December 15. Attendance 140.

Denver

The All-American Canal and the Problems of the Salton Basin, by M. M. McIntire, Imperial Irrigation District, Imperial, Calif. Illustrated with lantern slides. Dinner preceded the meeting. December 12. Attendance 32.

Detroit-Ann Arbor

Patents and Inventions, by George N. Willitts, General Motors Corporation, and Secretary Michigan Patent Law Association. Mr. Willitts pointed out the difficulties in the present patent procedure and outlined the reform in this system which the Michigan Patent Law Association has gone on record as favoring. Joint meeting with the Detroit Engineering Society. December 12. Attendance 125.

Fort Wayne

Transient Phenomena in Small Electromagnets, by H. H. Clayton, General Electric Co. Illustrated with slides.

Luminous Tubes and Transformers, by C. W. Kronmiller, General Electric Co. Considerable discussion followed. December 18. Attendance 70.

Houston

Banquet at which the members of the Section were guests of the International

Creosoting and Construction Co. Moving pictures were shown of modern methods used in the wood preserving industry. E. E. Boehne and Mr. Myers, both of the above company, explained various treatments and answered questions. December 16. Attendance 55.

Ithaca

TWENTIETH CENTURY DEVELOPMENTS IN OUR KNOWLEDGE OF MATTER AND ENERGY, by Professor F. K. Richtmyer, Cornell University. December 12. Attendance 200.

Kansas City

SOME CONSTRUCTION DETAILS IN AN INDUSTRIAL POWER PLANT, by C. O. Boynton, Standard Oil Co.;

SOME MECHANICAL ENGINEERING PROBLEMS IN A MODERN OIL REFINERY, by W. L. Mathews, Standard Oil Co.;

ECONOMIC DESIGN OF INTERCITY COMMUNICATION FACILITIES, by J. F. Burwick, Southwestern Bell Telephone Co.;

INTERCITY COMMUNICATION PLANT CONSTRUCTION, by J. H. Schweitzer, Southwestern Bell Telephone Co. Joint meeting with the University of Kansas Branches of A. I. E. E. and A. S. M. E. Buffet luncheon served at the close of the meeting. December 4. Attendance 180.

Lehigh Valley

POWER SUPPLY FOR SINGLE-PHASE RAILROAD ELECTRIFICATION, by R. T. Earle, Westinghouse Electric & Mfg. Co. C. L. Doud, Reading Railroad Co., outlined their activities in electrification in Philadelphia, and on some of their main trunk lines. Harvey Pierce, Stewart, James & Cook Co., who spent considerable time in Russia developing the coal fields, made a few remarks. Film—"Dynamic America," presented by E. M. Johnson, Westinghouse Electric & Mfg. Co. Meeting held at Pottsville. November 14. Attendance 73.

RECENT DEVELOPMENTS IN THE ART OF COMMUNICATION, by R. B. Parker, American Telephone & Telegraph Co. Illustrated with slides and an actual demonstration of the teletype. Film—"Transatlantic Radio Telephone Service." Joint meeting with the Student Branch at Lehigh University. December 5. Attendance 225.

Los Angeles

SOUND RAYS AS EXTREMALS, by Professor H. Bateman, California Institute of Technology. Discussion followed. December 15. Attendance 22.

Louisville

THE ROMANCE OF ELECTRIC COOKING, by K. L. Aleshire, Westinghouse Electric & Mfg. Co. Electric ranges, electric refrigerators, and other appliances were demonstrated. Refreshments served. December 15. Attendance 40.

Madison

THE APPLICATION OF AUTOMATIC CONTROL TO MOTOR-DRIVEN MACHINERY, by P. B. Harwood, Cutler-Hammer, Inc. Illustrated with slides. Refreshments served. November 19. Attendance 22.

Memphis

LIGHTNING AND LIGHTNING ARRESTERS, by H. T. Montgomery, General Electric Co. A motion picture was shown illustrating the construction of power transformers at the General Electric Works. December 9. Attendance 35.

Minnesota

AMUSING INCIDENTS OF MY TRIP TO EUROPE, by Milton Firestone, Attorney of St. Paul. Dinner preceded the meeting. December 17. Attendance 32.

Niagara Frontier

ARMOR-CLAD SWITCHGEAR, by H. V. Nye, Allis-Chalmers Mfg. Co., illustrated. R. L. Melton, The Carborundum Company, gave a talk on the manufacture of abrasives, preceding the showing of the four reel film "The Jewels of Industry." An informal dinner in honor of the speakers was held at the Hotel Niagara. December 19. Attendance 85.

Oklahoma City

PROTECTION OF POWER TRANSMISSION EQUIPMENT FROM LIGHTNING, by Professor C. T. Almquist, University of Oklahoma.

PROTECTION OF TELEPHONE EQUIPMENT FROM LIGHTNING, by R. L. Jones, Southwestern Bell Telephone Co. General discussion of both talks followed. December 29. Attendance 59.

Philadelphia

INNOVATIONS IN REMOTE METERING, by Alan S. Fitzgerald, Radio-Victor Corp. December 8. Attendance 150.

PROBLEMS IN THE DESIGN OF LARGE TURBO ALTERNATORS, by S. H. Mortensen, Allis-Chalmers Mfg. Co. Illustrated with slides which not only showed the steps in the manufacture of the various parts, but compared the European design with American practise. January 5. Attendance 105.

Pittsburgh

PROPER VOLTAGE AND LIGHTING SERVICE, by G. S. Merrill, General Electric Co.;

ARTIFICIAL SUNLIGHT, by M. Luckiesh, General Electric Co. Film—"Dynamic America" presented. Joint meeting with the Engineers' Society of Western Pennsylvania. December 9. Attendance 282.

Pittsfield

TELEGRAPHY—A NEW ART WITH AN OLD NAME, by J. H. Bell, Bell Telephone Laboratories, Inc. Illustrated with slides and curves. Dinner preceded the meeting. December 16. Attendance 175.

Rochester

ILLUMINATION, by Alvin L. Powell, General Electric Company. Illustrated with colored slides of modern uses of lighting. December 11. Attendance 186.

St. Louis

SOME RECENT RESEARCH DEVELOPMENTS, by E. L. Manning, General Electric Co. C. B. Fall, Chairman, spoke of the legislation now under consideration for the licensing of engineers in Missouri, and appointed a committee to represent the interests of the Section. December 19. Attendance 95.

San Antonio

Film and descriptive talk on FORT WORTH TO CISCO UNDERGROUND TOLL CABLE, by B. O. Timberlake, Southwestern Bell Telephone Co.;

Film and descriptive talk on STEP BY STEP MACHINE SWITCHING, by L. R. Norton, Southwestern Bell Telephone Co. Film—"Voices Across the Seas." December 15. Attendance 76.

Schenectady

AUTOMOTIVE DESIGN, by John J. Caton, Chrysler Motor Corporation. Discussion followed. November 21. Attendance 200.

ELECTRICITY—PAST, PRESENT, AND FUTURE, by C. M. Ripley, General Electric Co. Film—"Tipping the Chute—a Caron Obelisk." December 5. Attendance 250.

Seattle

A RESUMÉ OF RECENT DEVELOPMENTS IN PREDETERMINATION OF SYSTEM PERFORMANCE, by Dean H. V. Carpenter, State College of Washington. Discussion followed. December 23. Attendance 40.

Sharon

SPLIT-SECOND PHENOMENA IN ELECTRICAL ENGINEERING, by Dr. Joseph Slepian, Westinghouse Electric & Mfg. Co., assisted by Dr. Phillips Thomas of the same company. Illustrated with slides and demonstrations, including a 250-kv. lightning generator, insulator strings, and auto valve arrester. Film showing equipment and operation of the Wildwood Mine of the Butler Consolidated Coal Company was supplemented by a description by Mr. Vance, Chief Engineer of that company. January 6. Attendance 140.

Springfield

THE MARVELS OF SOUND TRANSMISSION, by Sergius P. Grace, Assistant Vice-president, Bell Telephone Laboratories, Inc. Joint meeting with the Engineering Society of Western Massachusetts and the Springfield Chamber of Commerce. Dinner in honor of the speaker was given at the Colony Club. December 12-13. Attendance 9,000.

Toledo

Zig-Zag Transformers, by Alois Hoefle, Toledo Edison Co., illustrated with sketches and diagrams.

Economic Advantages of Electric Heat for Heat-Treating Processes, by Wirt S. Scott, Westinghouse Elec. & Mfg. Co., illustrated with lantern slides. December 19. Attendance 80.

Toronto

Changing Views of the Nature of Matter, by Dr. Saul Dushman, General Electric Co. Joint meeting with the Toronto Chemical Association. December 12. Attendance 300.

Hydrogen Cooling of Electrical Machinery, by C. J. Fechheimer, Westinghouse Electric & Mfg. Co., illustrated with slides. General discussion followed. January 9. Attendance 102.

Urbana

Research Laboratory in a Large Manufacturing Company, by H. D. Sanborn, General Electric Co. Illustrated with lantern slides showing some of the wide variety of subjects undertaken in a research laboratory. December 19. Attendance 75.

Utah

Automatic Block Signals, by B. W. Molis, Denver & Rio Grande Western Railroad Co. Mr. Molis gave a description of the common forms of train control and signal arrangements, and had some apparatus for demonstration. Informal dinner preceded the meeting. December 8. Attendance 41.

Vancouver

Manufacture and Application of Vacuum Tubes, by G. W. Sweney, Neon Products of Western Canada Ltd. Lantern slides and films were shown illustrating the manufacture, installation, and application of neon tubes. November 17. Attendance 57.

Photoelectric Cells—Their Construction, Selection and Application, by Frank Sawford, Consulting Mechanical and Electrical Engineer. Charts were displayed and smoke-density metering equipment designed and patented by Mr. Sawford was set up for demonstration purposes. December 8. Attendance 53.

An Outline of Modern Automatic Telephone Practise, by R. S. Bowland, Independent Sales & Engineering Co. Illustrated with slides, and a demonstration, consisting of two telephones with their dials, switching equipment, and battery, was set up and operated. January 5. Attendance 52.

Washington

The Electrification of the Pennsylvania Railroad, by H. C. Griffith, Pennsylvania Railroad Co. Illustrated with slides showing various types of locomotives, overhead construction, and equipment used in construction work. Dinner in honor of the speaker preceded the meeting. December 9. Attendance 162.

Worcester

The Marvels of Sound Transmission, by Sergius P. Grace, Assistant Vice-president, Bell Telephone Laboratories, Inc. Meeting held under the auspices of the Worcester Engineering Society. December 17-18. Attendance 3500.

Insulated Wires and Cables for Power Circuits, by E. W. Davis, Simplex Wire & Cable Co. January 7. Attendance 35.

Past Branch Meetings

University of Akron

A History of Telephony, by Harold Schroeder, Branch Secretary. December 19. Attendance 18.

Alabama Polytechnic Institute

Steam Electric Power Plant, by L. O. Swint, Student;

Levee Construction Along the Mississippi River, by Charles Perry, Student;

Dirigible Construction, by E. C. Austin, Student. October 2. Attendance 36.

The Process of Manufacturing One Piece Wheel and Axle for Railroad Cars, by K. R. Clark, Student;

Testing Wattmeters, by J. M. Johnson, Student. October 9. Attendance 25.

Redevelopment of Hydroelectric Plants, by T. N. Pyke, Student;

Electricity's Part in Copper Mining, by G. A. Beavers, Student;

Experience Working with an Engineering Party, by H. L. Beck, Student. October 23. Attendance 16.

Smoker and entertainment. October 30. Attendance 76.

Molding Cast Iron Pipe by the Centrifugal Method, by S. E. Garrett, Student. November 6. Attendance 15.

R. A. Mann, representative of the Branch, outlined the activities of the District meeting held in Louisville. G. A. Beavers gave an account of the Eta Kappa Nu meeting held in Ames, Iowa. December 4. Attendance 17.

Election of officers as follows: R. A. Mann, Chairman; C. L. Perry, Vice-Chairman; L. B. Crouch, Secretary-Treasurer; K. R. Clark, Reporter. December 11. Attendance 12.

University of Alabama

Copper-Weld Wire, by W. B. McClure, Student;

Lightning Investigation on 110 Kv. Line, by Harold B. Hendrix, Branch Secretary. Walter H. Croft, Chairman, gave a report of his trip to the District meeting held in Louisville. December 8. Attendance 16.

University of Arizona

A Trip Through the East, by A. W. Fraps, Student. October 24. Attendance 10.

Industrial Use of Vacuum Tubes, by C. J. Sabin, Student. October 31. Attendance 8.

Television, by H. P. McGovern, Student. C. J. Sabin appointed Chairman of Electrical Show. November 7. Attendance 8.

A Brief Review of the Development of Power Plants, by Max Pooler, Tucson Gas, Electric Light and Power Company. Banquet meeting. November 19. Attendance 25.

Talkies, by J. C. Hall, Student. November 21. Attendance 9.

Business meeting. December 5. Attendance 10.

Circuit Breakers, by W. T. Brinton, Student;

Vacuum Tube Circuit Breaker, by Professor J. C. Clark, Counselor. December 12. Attendance 10.

Thermodynamic Regulator, by R. Manzo, Student. December 19. Attendance 10.

University of Arkansas

Film—"The Single Ridge." November 19. Attendance 22.

Grid-Glow Tube and Photoelectric Cell, by Wylie Head, Branch Secretary. Demonstrated. December 3. Attendance 23.

Armour Institute of Technology

Smoker. December 10. Attendance 87.

Industrial Electric Heating, by L. J. Ericsson, General Electric Co. Illustrated with motion pictures. December 15. Attendance 40.

Polytechnic Institute of Brooklyn

Substation Maintenance Practise, by Rodney Brabson, Student;

Electrolysis of Subway Cables in Telephone Work, by Leon K. Danner, Student;

High-Frequency Currents and Short Radio Waves as Valuable Adjuncts to the Medical Sciences, by Ivan Block, Student. There were two prizes; first won by Ivan Block, and second by Leon K. Danner. December 12. Attendance 33.

Carnegie Institute of Technology

Commercial Problems that an Electrical Engineer is Required to Face in the Steel Industry, by William Skinkle, United States Steel Corporation, and Director of the Engineers' Society of Western Pennsylvania. Illustrated with slides. November 13. Attendance 30.

Electrical Engineering in an Electric Public Utility, by R. L. Kirk, Duquesne Light Co. December 9. Attendance 85.

Catholic University of America

The Fundamentals of Radio, by Professor T. J. MacKavanagh, Counselor. December 16. Attendance 30.

University of Cincinnati

Public Utilities and the Public, by E. D. Gilman, Director, Public Utilities of the City of Cincinnati. December 10. Attendance 26.

Colorado Agricultural College

The Public Relations with Public Utilities, by Mr. Jamison, Public Service Co. of Colorado. December 8. Attendance 16.

University of Denver

Aviation Lighting, by F. L. Woodward, Student. November 8. Attendance 18.

Film—"Beyond the Microscope." December 12. Attendance 40.

University of Detroit

The Principles of X-Rays, by C. J. Haller, General Electric X-Ray Corporation. November 24. Attendance 40.

University of Florida

A history of the A. I. E. E. and its activities was given by Professor W. S. Rodman, University of Virginia, and Vice-President District No. 4, A. I. E. E. Professor Rodman also gave an address, Some Aspects of the Scientific Work of Thomas Jefferson, through the University of Florida radio station, WRUF. December 17. Attendance 63.

Arc Welding, by F. J. Nelson, Student. Discussion of Branch affairs. January 12. Attendance 20.

University of Iowa

Films—"The Wizardry of Wireless," and "Liquid Air." December 17. Attendance 40.

The Part of Electricity in Open-Cut Copper Mining, by Mr. Hammond, Student;

The Oscillograph, by Mr. Jenkins, Student. January 7. Attendance 41.

University of Kansas

The Design and Testing of Motion Picture Screens for Sound Picture Work, by Lester Perry, Student;

The Applications of Photoelectric Cells, by Louis Farber, Student. A three-reel film on transmission cable insulation was shown. December 18. Attendance 55.

Lehigh University

Recent Developments in the Art of Communication, by R. D. Porter, American Tel. & Tel. Co. Joint meeting with the Lehigh Valley Section. December 5. Attendance 250.

University of Maine

Election of officers as follows: Monroe E. Moon, President; S. L. Scheffer, Vice-president; L. O. Spencer, Secretary; H. G. Marshall, Treasurer. September 25. Attendance 15.

Talks by D. B. Henderson and L. O. Spencer, Students, on their summer experiences. Professor W. E. Barrows, Jr., Counselor, outlined the N. E. L. A. convention, and described the progress and future possibilities in the field of illumination engineering. October 30. Attendance 20.

Smoker and entertainment. Demonstrations of high-frequency phenomena and Tesla effects. November 20. Attendance 250.

Railway Electrification, by S. L. Scheffer, Student. Professor W. E. Barrows, Jr., Counselor, gave a demonstration of some new illumination equipment received from the General Electric Co. December 11. Attendance 16.

Marquette University

Films—"Blasting the Water Highways of America," and "Hydroelectric Power Production in the New South." December 4. Attendance 22.

Massachusetts Institute of Technology

The Opportunities for the Graduate who Enters Electrical Manufacturing, by C. E. Eveleth, Vice-President, General Electric Co. Dinner preceded the meeting. January 7. Attendance 300.

Michigan College of Mining and Technology

Substations and Their Uses, by E. E. Chilberg, General Electric Co.;

Transformers, by I. E. Devlin, General Electric Co. Illustrated with educational films. December 9. Attendance 31.

University of Michigan

Materials in the Magnetic Circuits of Communication Apparatus, by Dr. Remmers, Western Electric Co. Illustrated with slides showing the characteristics, manufacturing processes, and uses of many magnetic materials. An explanation of the various branches of the Bell System was given by J. T. Schaefer, Michigan Bell Telephone Co. R. A. Price, Western Electric Co., made a few remarks. December 17. Attendance 55.

School of Engineering of Milwaukee

The Story of Electrical Inspection, by Wm. Haig, Head of Electrical Inspection Department of the City of Milwaukee, assisted by Mr. Crickie. December 3. Attendance 41.

Mississippi A. & M. College

J. M. Leigh, Chairman, gave an outline of the various activities at the District Meeting held in Louisville. December 5. Attendance 31.

University of Missouri

Rectox Rectifiers, by Mr. Vincill, Student. January 7. Attendance 23.

Montana State College

Vacuum Tubes, by B. L. Snoddy, General Electric Co. December 4. Attendance 126.

Developing Power from Sea Water, taken from the *Electrical World*, presented by A. J. Hill, Student;

Successful Trolley Bus Operation Demands Suitable Overhead, taken from *Railway Journal*, presented by A. T. Keene, Student;

The Breathing Battery, taken from *Radio World*, presented by H. T. Lambdin Student;

Night Football, taken from *Electrical World*, presented by R. MacDonald, Student;

A New Weather Broadcasting Station in Butte, by Henry Nervobig, Student. December 11. Attendance 130.

University of Nebraska

Professor F. W. Norris, Counselor, gave an illustrated talk, describing the action of the telephone typewriter used by the Bell System. December 17. Attendance 14.

Newark College of Engineering

Double-Wound Generators, by F. W. Gay, Public Service Production Co. December 15. Attendance 28.

Electrical Horology, by W. R. Ackor, Chairman. Demonstrated. January 5. Attendance 29.

University of New Mexico

The Vacuum Tube, by S. M. Pelatowski, Student;

The Life of C. P. Steinmetz, by R. Harris, Student. December 17. Attendance 9.

North Carolina State College

Some Aspects of the Scientific Work of Thomas Jefferson, by Professor W. S. Rodman, University of Virginia, and Vice-president District No. 4, A. I. E. E. Banquet in honor of new members preceded the meeting. December 10. Attendance 60.

Film—"From Coal to Electricity." D. P. Melton, Student, explained the proposed exhibits for the Engineers Fair. January 6. Attendance 40.

University of North Carolina

The Manufacture of Porcelain Insulators, by E. W. Winkler, Instructor;

Pulverized Fuel, by E. R. Davis, Student. November 20. Attendance 41.

Some Aspects of the Scientific Work of Thomas Jefferson, by Professor W. S. Rodman, University of Virginia, and Vice-president District No. 4, A. I. E. E. December 11. Attendance 80.

Northeastern University

Engineering Ethics, by H. C. Hamilton, Edison Electric Illuminating Co. of Boston. Refreshments were served. December 2. Attendance 49.

University of Notre Dame

Structural Arc Welding, by W. M. Brady, General Electric Co., illustrated with motion pictures and slides.

The Life of Volta, by P. A. Darmody, Student;

The Development of the Incandescent Lamp, by J. B. Strebinger, Student. Patrick Murray, Student, presented the regular engineering news digest. December 9. Attendance 70.

Ohio University

The Photo-Flash Bulb, by William Miller, Student. Film—"Liquid Air." December 15. Attendance 14.

Oklahoma A. & M. College

Two films—"Induction Voltage Regulators," and "The Vacuum Tube Synchronizing Equipment." December 4. Attendance 47.

Relays, by Paul Foster, Student. Illustrated with slides. December 18. Attendance 12.

Oregon State College

Carrier-Current Telephony, by W. R. Deardorff, Pacific Tel. & Tel. Co. W. A. Kleist, of the same company, supplemented Mr. Deardorff's talk. December 9. Attendance 25.

Pratt Institute

Transmission of Pictures by Wire, by Mr. O'Nasch, New York Telephone Co. Illustrated with slides. December 18. Attendance 180.

Princeton University

Magnetic Potentiometers, by R. M. Kime, Student;

The Generation of Steam, by Ernest E. George, Student. December 11. Attendance 10.

Purdue University

The Storage Battery—A Box Full of Problems, by R. J. Kryter, Prest-O-Lite Storage Battery Co. December 9. Attendance 35.

Rensselaer Polytechnic Institute

New General Electric Permanent Magnet Oscillographs, by Claude Hathaway, General Electric Co. December 9. Attendance 130.

University of South Carolina

What is Expected of the College Graduate, by R. E. Brooks, Student;

The Development of Arizona, by W. T. Thomas, Student. December 8. Attendance 40.

Some Aspects of the Scientific Work of Thomas Jefferson, by Professor W. S. Rodman, University of Virginia, and Vice-President District No. 4, A. I. E. E. December 15. Attendance 125.

Election of officers as follows: L. E. Rankin, Chairman; C. H. Bryan, Vice-chairman; W. Dickerson, Secretary-Treasurer. January 5. Attendance 14.

South Dakota School of Mines

Annual Frolic with entertainment and luncheon. December 16. Attendance 116.

University of Southern California

High-Tension Line Construction, by Clayton M. Allen, Bureau of Power & Light. December 10. Attendance 29.

Southern Methodist University

Ultra Short-Wave Transmission, by J. D. Tucker, Student. December 9. Attendance 21.

Stanford University

Address by Dean Dexter S. Kimball of Cornell University. Joint meeting with the A. S. M. E. Branch. December 9. Attendance 50.

Stevens Institute of Technology

Election of officers as follows: George J. Costello, Chairman; Edmund Starzec, Secretary. General discussion of Branch activities. December 11. Attendance 9.

Film—"The Single Ridge." December 19. Attendance 17.

The Life of Michael Faraday, by Paul H. Beier, Student. January 8. Attendance 30.

Swarthmore College

Discussion of plans for the coming A. I. E. E. Student Convention to be held at Swarthmore College. January 7. Attendance 11.

Syracuse University

The Radio Beacon, by Alex Paterson, Student;

Carrier Current in Telephony, by Chester Grant, Student. December 12. Attendance 25.

The Photoelectric Cell, by Oliver Bigsby, Student;

Television, by Stewart Darrow, Student. December 19. Attendance 25.

Sperry Gyroscopic Stabilizers, by Stanley Scerbinski, Student;

Non-Resonating Transformers, by George Cowell, Student. January 9. Attendance 25.

Texas A. & M. College

Electric Refrigeration, by George Cushman, Student;

Gas Refrigeration, by R. L. Allen, Student. November 24. Attendance 50.

Film—"Oil Circuit Breakers." December 8. Attendance 50.

University of Texas

General discussion and plans made for a banquet meeting. September 23. Attendance 20.

Why I Became a Member of the A. I. E. E., by C. A. Glover, Student. Dinner preceded the meeting. September 29. Attendance 80.

Short talks by Professor J. A. Correll, Counselor, and Lyle Burnham, Student. October 15. Attendance 41.

History of Hydroelectric Development at Austin, Texas, by T. E. Cole, Student. December 11. Attendance 17.

University of Vermont

Properties of Perminvar and Permalloy, by Professor R. O. Buchanan. Illustrated. December 16. Attendance 24.

University of Washington

The Applications of the Photoelectric Cell, by J. Mackay, Student. December 4. Attendance 20.

The Rock Island Development, by Mr. DeMuth, Stone & Webster Engg. Corp. November 20. Attendance 74.

Washington University

Economic Aspects of the Generation of Power, by Professor Roy S. Glasgow. December 11. Attendance 21.

Engineering Literature

New Books

In the Societies Library

AMONG the new books received at the Engineering Societies Library, New York, during December are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface or text of the book in question.

Sound Waves and Their Uses. By Alexander Wood. Lond. & Glasgow, Blackie & Son, 1930. 152 pp., illus., diagrs., tables, 9 x 6 in., cloth. 7/6.——These six lectures delivered at the Royal Institution give a remarkably readable, well illustrated account of modern development in acoustics. Methods of signaling in air and water, noises, the analysis of sounds, the ear, and the recording and reproduction of sound are discussed. The book is suited to the general reader without previous training, but references are included for those who wish further information.

Acoustics; a Text on Theory and Applications. By George Walter Stewart and Robert Bruce Lindsay. N. Y., D. Van Nostrand Co., 1930. 358 pp., diagrs., tables, 9 x 6 in., cloth. $5.00.——The increasing use of acoustical apparatus has created a need for better understanding of the theory of acoustics. The present book aims to meet the need by providing a clear exposition of the theory, in which modern applications are kept to the fore. The book is intended to provide the equipment necessary for attacking mathematically the problems that confront the designer of telephone equipment, the architect and other investigators.

A Century of Wood Preserving. Edited by Sir Harold Boulton. London, Philip Allan & Co., 1930. 150 pp., plates, 9 x 6 in., cloth. 8/6.——A collection of papers upon wood preservation, especially by creosoting, which form an account of the development of the art during the hundred years that have passed since John Bethell became interested in the subject. Bethell's patent is given in an appendix, and there is a long list of references on wood preservation.

Diesel Power Plant Handbook (formerly the Oil Engine Power Plant Handbook). 6th edition. By Julius Kuttner. N. Y., Diesel Power, 1930. 280 pp., illus., 11 x 8 in., fabrikoid, $5.00.——The text of this edition consists of a practical course on the operation and maintenance of Diesel engines, which should meet the ordinary requirements of the engine room. In addition the book contains condensed descriptions of the Diesel engine manufacturers of the United States.

Electric Circuit Analysis. By Michel G. Malti. N. Y., John Wiley & Sons, 1930. 389 pp., diagrs., tables, 9 x 6 in., cloth. $4.50.——In this book the author first discusses complex numbers, vectors and the theory of sine functions. The electric units and their dimensions are then studied, after which the characteristics of an electric circuit are explained. The steady and transient phenomena in an electric circuit are then discussed at length. The book represents the course in circuit analysis given at Cornell University.

Electrical Power Transmission and Interconnection. By C. Dannatt and J. W. Dalgliesh. N. Y., Isaac Pitman & Sons, 1930. 424 pp., diagrs., tables, 9 x 6 in., cloth. $7.50.——The bulk transmission of electrical energy has become a major engineering problem, presenting new and wide issues, upon which much scattered literature exists. To obviate the laborious search for this, the authors have attempted to provide a complete introduction to the electrical aspects of power transmission and interconnection. Overhead and underground lines, corona, network theory, line calculations, power and stability, interference, neutrals, and transient voltage phenomena are among the topics treated.

Electricity and Magnetism. By Charles A. Culver. N. Y., Macmillan Co., 1930. 383 pp., illus., diagrs., tables, 9 x 6 in., cloth. $3.25.——Intended to give students of the liberal arts a reasonably thorough understanding of the fundamental principles of electricity and magnetism and of their commercial applications.

Flights from Chaos. By Harlow Shapley. N. Y., Whittlesey House; McGraw-Hill Book Co., 1930. 168 pp., 9 x 6 in., cloth. $2.50.——Dr. Shapley here presents his conception of order in the apparent chaos of the universe, and develops a general, complete classification of all material systems, from electrons to the galaxy of galaxies, into a series of classes of ever increasing size and mass. The book is based upon a series of lectures and is addressed to the lay reader.

Hydraulics for Engineers and Engineering Students. By Frederick Charles Lea. 5th edition. N. Y., Longmans, Green & Co., 1930. 775 pp., illus., diagrs., tables, 9 x 7 in., fabrikoid. $7.50.——The new edition of this well-known text-book apparently has been entirely reset, and in the process the accumulated appendices have been incorporated in the text. A considerable amount of material upon recent researches and developments and a chapter on dynamic similarity have been added.

The book offers a clear, practical exposition of the fundamentals of hydraulics, with illustrations of their applications to water wheels, pumps and hydraulic machines, and to the measurement of the flow of water.

Manuale Pratico di Telegrafia Sottomarina. By Italo de Guili. Milano, Ulrico Hoepli, 1931. 384 pp., illus., diagrs., tables, 6 x 4 in., cloth. 30 lire.——A textbook on submarine cable practise for students and operators. The construction of lines and apparatus is described in detail. Theory is reduced to the minimum.

Patent Rights for Scientific Discoveries, By C. J. Hamson. Indianapolis, Bobbs-Merrill Co., 1930. 286 pp., 9 x 6 in., fabrikoid. $5.00.——This monograph, which received the Charles C. Linthicum Foundation prize in 1929, discusses the important new legal idea of "scientific property." The author reviews the historical development of the idea and past attempts to protect the rights of discoverers of scientific facts, and discusses the problems that arise in formulating a law to protect discoverers. The draft of a proposed statute is given and the objections to it discussed.

Starkstromtechnik, vol. 2. Edited by E. V. Rziha and J. Seidener. 7th edition. Berlin, Wilhelm Ernst & Sohn, 1931. 1034 pp., illus., diagrs., tables, 7 x 5 in., cloth. 37.-r. m.——Corresponds in form and character to American "handbooks" of electrical engineering. The present (second) volume covers the production and transmission of electric energy, and its use in mining and agriculture, for hoisting and rolling metals and in factories. The new edition has been thoroughly revised by a number of specialists.

A Study of the Induction Motor. By F. T. Chapman. N. Y., John Wiley & Sons, 1930. 289 pp., illus., diagrs., 9 x 6 in., cloth. $5.50.——Dr. Chapman develops the theory of the induction motor and discusses the characteristics of the various types, using only simple algebra and geometry in his argument.

Theorie der Wechselströme. By Alfred Fraenckel. 3rd edition. Berlin, Julius Springer, 1930. 260 pp., illus., diagrs., 10 x 7 in., bound. 21,50 r. m.——A concise text-book for students of electrical engineering, intended to present the knowledge of alternating-current theory needed by the practical engineer, and to train him in the graphic and analytic methods used to investigate the phenomena of a-c. circuits.

Artificial Sunlight; combining radiation for health with light for vision. By M. Luckiesh. N. Y., D. Van Nostrand

ENGINEERING SOCIETIES LIBRARY
29 West 39th Street, New York, N. Y.

MAINTAINED as a public reference library of engineering and the allied sciences, this library is a cooperative activity of the national societies of civil, electrical, mechanical, and mining engineers.

Resources of the library are available also to those unable to visit it in person. Lists of references, copies or translation of articles, and similar assistance may be obtained upon written application, subject only to charges sufficient to cover the cost of the work required.

A collection of modern technical books is available to any member residing in North America at a rental rate of five cents per day per volume, plus transportation charges.

Many other services are obtainable and an inquiry to the director of the library will bring information concerning them.

Co., 1930. 254 pp., illus., diagrs., tables, 9 x 6 in., cloth. $3.75. Dr. Luckiesh discusses the need for artificial sunlight, our methods of producing and controlling it, and the fields in which it may be applied. Much physical and biological information is given upon radiant energy, the advantages of the "sunlight lamp" are explained and compared with those of other sources of ultraviolet rays. Practical methods of dual-purpose lighting are discussed.

Brown's Directory of American Gas Companies and Gas Engineering and Appliance Catalogue. 1930. N. Y., Robbins Publishing Co., 1930. 284-369 pp., illus., 12 x 9 in., cloth. $15.00.——As in previous editions, we find here the gas statistics of the companies supplying manufactured and natural gas in North America and of the holding and operating companies in the continent. The members of public service commissions are also listed, and the officers and members of gas associations. In addition the volume contains condensed catalogs of manufacturers of gas equipment and supplies. The statistics are revised to date and include those ordinarily wanted.

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Selected Items *From*

Engineering Index Service

SELECTED references to current electrical engineering articles from Engineering Index Service's review of some 1,800 technical periodicals are given in the following columns.

All articles indexed are on file in the Engineering Societies Library, New York, which will furnish photoprints of any article at a cost of 25 cents per page or make translations of foreign articles at cost.

Arcs

ALTERNATING CURRENT. Supply of Electric Arcs with Alternating Current (Considérations générales sur l'alimentation des arcs a courant alternatif), A. de Stavraky. *Revue d'Électricité et de Mécanique (Paris)*, no. 13, Sept.-Oct. 1930, pp. 10-11, 3 figs. Equipment derived from P. Boucherot's and J. Berthenod's suggestions is reviewed; remedies for instability and for improvement of power factor are suggested; the theoretical study of these apparatus are given in same number of journal.

Brakes

ELECTRIC. New Methods of Approach for Explanation and for Improving Results in Braking of Street Railroad Cars (Neue Wege zur Klaerung der Vorgaenge und zur Verbesserung der Ergebnisse bei der Bremsung von Strassenbahnwagen), R. Boehm. *Verkehrstechnik (Berlin)*, no. 47, Nov. 21, 1930, pp. 625-630, 18 figs. Present electric braking equipment of Nuernberg-Fuerth line and results obtained; relation between maximum and average braking retardation; influence of slipping and sanding, cinematographic-oscillographic method of research; improved braking results.

Cables

ALUMINUM. Aluminum in Armoured Electric Cables (L'aluminium dans les cables electriques armes). *Radioélectricité et QST Francais (Paris)*, vol. 11, no. 81, Dec. 1930, pp. 28-30, 4 figs. Composition, conductor material, insulation resistance, disruptive strength; excessive voltages and currents, laying qualities; comparison between copper and aluminum conductors from economical standpoint, armoring.

LEAD SHEATHING. Flow Characteristics of Some Lead Cable Sheath at Temperatures Above Atmospheric, C. L. Clark and C. Upthegrove. *Fuels and Steam Power (A. S. M. E. Trans.)*, vol. 52, no. 27, Sept.-Dec. 1930, pp. 249-254, 16 figs. Paper previously indexed from Advance Paper, no. 1, for mtg. June 9-12, 1930.

OIL FILLED. 75-Kv., Three-Conductor, Oil-Filled Cable, E. F. Nuezel. *Elec. World*, vol. 96, no. 24, Dec. 13, 1930, pp. 1088-1092, 16 figs. Union Gas & Electric Co. has taken step forward in oil-filled cable field with recent installation at its Columbia station; cable is first installation of 75-kv. three-conductor, shielded conductor type, oil-filled cable in this country; many features in design of cable and its accessory equipment are entirely new and original developments of General Electric Co. to meet particular requirements of installation.

SPLICING COMPOUNDS. Tentative Methods of Testing Cable Splicing and Pothead Compounds. *Am. Soc. Testing Metals.—Tentative Standards*, 1930, pp. 564-570, 2 figs. Methods cover: physical tests; dielectric strength test and coefficient of expansion.

TELEPHONE, SUBMARINE. Two-Band Communication from Helgoland to Cuxhaven and Hamburg (Zweibandsprechen von Helgoland nach Cuxhaven und Hamburg), W. Weinitschke. *Telegraphen und Fernsprech Technik (Berlin)*, vol. 19, no. 10, Oct. 1930, pp. 310-312, 6 figs. Use of 80 km. telephone telegraph cable which had become overloaded with traffic is now used for two band carrier current telephony which has brought solution and satisfactory results; measurements; curves.

Canals

ELECTRIC EQUIPMENT. The Electrical System of the Welland Ship Canal, A. L. Mudge, L. P. Rundle and F. A. Pankhurst. *Elec. News (Toronto)*, vol. 39, no. 22, Nov. 15, 1930, pp. 49-86, 63 figs. Description of power house, step-up transformer station, transmission line, substations, lock distribution system, motors and control equipment, lock operation, signals, bridges, lighting, heating, telephones, standardization, foreign cable crossings and gate lifter.

Car Lighting

Electric Train Lighting on Secondary Railroads (l'eclairage electrique des trains de chemins de fer secondaries), Vincent. *l'Industrie des Voies Ferrées et des Transports Automobiles (Paris)*, vol. 24, no. 286, Oct. 1930, pp. 278-282, 6 figs. Review of relative merits of various equipment and makes with particular regard to systems using battery and generator driven from axle, including Systeme E. V. R., Systeme Brown-Boveri.

Ceramic Kilns

ELECTRIC. Electric Heat for Ceramic Kilns, J. T. Jans. *Ceramic Age*, vol. 16, no. 6, Dec. 1930, pp. 326-327 and 330, 1 fig. Characteristics of high and low temperature kilns. Paper presented before New Jersey Clay Workers Assn., Oct. 1930.

Circuit Breakers

OIL. Oil Circuit Breaker Design. *Elec. Times (Lond.)*, vol. 78, no. 2039, Nov. 20, 1930, pp. 885-887, 5 figs. Phenomena of arc rupturing with special reference to the R type oil circuit breaker of Ferguson, Pailin, Ltd.

SPEED CHARACTERISTICS. Circuit-Breaker Duty Affected by Speed, C. L. Denault. *Elec. World*, vol. 96, no. 20, Nov. 15, 1930, pp. 913-915, 5 figs. When circuit is opened by breaker voltage recovers; circuit characteristics determine rate of voltage recovery; delayed recovery promotes deionization, less arc length, time and energy.

Clocks

ELECTRIC. Clocks and Apparatus with Synchronous Motor, A. Rabinowitsch. *AEG Progress (Berlin)*, vol. 6, no. 12, Dec. 1930, pp. 374-378, 12 figs. Advantages of electric clocks and other control apparatus equipped with synchronous motors.

Coal Mines

ELECTRIC DRIVE. Electric Drives for Main Shaft Ventilators (Die elektrischen Antriebe fuer Hauptschachtluefter), K. Schade. *Elektrizitaet im Bergbau (Munich)*, vol. 5, no. 11, Nov. 15, 1930, pp. 205-216, 25 figs. Determination of required power and details of drive; regulatable drives; wiring diagrams of various combinations and systems; equipment described and illustrated. (To be continued.)

ELECTRIC EQUIPMENT. Power Consumption, Output, and Economy of Electric Haulage Equipment and Coal Cutters in Underground Coal Mining (Energieverbrauch, Leistung und Wirtschaftlichkeit der elektrischen Abbaufoerdereinrichtungen und Schraemmaschinen im untertaegigen Steinkohlenbergbau), E. Meyer. *Elektrizitaet im Bergbau (Munich)*, vol. 5, no. 10, Oct. 10, 1930, pp. 185-203, 16 figs. Results of measurements on equipment of various types are summarized in curves and tables.

Commutators

High Speed Commutators, B. Bonnell. *Elec. Times (Lond.)*, vol. 78, no. 2037, Nov. 6, 1930, pp. 791-792, 4 figs. Suggestions for manufacture of high-speed commutators of "V" ring construction.

Condensers

POWER FACTOR IMPROVEMENT. Electric Power Condensators for Reactive Current Compensation and their Economy in Industrial Installations (Starkstrom-Kondensatoren zur Blindstrom-Kompensation und ihre Wirtschaftlichkeit in Industrieanlagen), H. Cypra. *Elektrizitaet im Bergbau (Munich)*, vol. 5, no. 11, Nov. 15, 1930, pp. 216-219, 6 figs. Condensers are recently favored over rotating equipment because of low internal losses and simple and safe installations; features are described and equipment of AEG illustrated; internal loss curves are given in accordance with reactive load.

Conductors

Propagation of Electricity Through Conducting Wire (Propagation de l'électricité dans un fil conducteur), J. Granier. *Radioélectricité et QST Francais (Paris)*, vol. 11, no. 81, Dec. 1930, pp. 6-9, 1 fig. Theoretical mathematical analysis in which all line characteristics are considered, discussing also various practical cases as for instance, series equation showing potential distribution along line, application to submarine and underground cables, etc.

RESISTANCE. Ohmic Resistance of Copper Conductors at High Frequency (Résistance ohmique des conducteurs en cuivre en haute fréquence), M. Mathieu. *Arts et Métiers (Paris)*, vol. 83, no. 122, Nov. 1930, p. 450, 1 fig. Curve gives values of constants for conductors from 0.1 to 10 mm. at frequencies from 10 to 300,000 kilocycles.

STRENGTH. Stretch of Wire Cables (Die Dehnungsarbeit am Seilen), J. Groebl. *Elektrotechnische Zeit. (Berlin)*, vol. 51, no. 49, Dec. 4, 1930, pp. 1669-1673, 6 figs. Investigation mainly refers to wire cables used in electric transmission lines; notes on torsion as factor of stretch; number of torsions as function of tensile strength; equation of torsion curve in over proportional range; calculation of torsional stretch; normal stretch equation; calculation of fictive elasticity modulus. (To be concluded.)

Conductivity

ELECTRIC. Recent Studies of Supraconductivity (Neue Untersuchungen ueber Supraleitfaehibkeit). *Zeit. fuer die gesamte Kaelte-Industrie (Berlin)*, vol. 37, no. 11, Nov. 9, 1930, pp. 218-220. Report on works of W. J. de Haas, E. van Aubel and T. Voogd; investigation to determine change in conductive characteristics of combination of supraconductor with non-supraconductor to alloy; reference is made to experiments in Leiden and Toronto.

Cranes

ELECTRIC. Improved Electrical Crane Equipment, B. Erenyi. *AEG Progress (Berlin)*, vol. 6, no. 12, Dec. 1930, pp. 372-373, 3 figs. Improvements described are "telegraphing" system of switching (tap control) and two-speed crane motor.

Dielectrics

ELECTRIC CONDUCTIVITY. The Conduction of Electricity in Liquid Dielectrics, D. H. Black and R. H. Nisbet. *Lond., Edinburgh, and Dublin Philosohpical Mag. and Jl. of Science (Lond.)*, vol. 10, no. 66, Nov. 1930, pp. 842-861, 11 figs. Possibility of applying theory of conduction in gases to conduction in liquid dielectrics is investigated; gas theory is considered as leading to distribution of internal resistances, and is shown to be special case of general theory advance in previous paper which attributed fall of current usually known as "absorption" to formation of internal resistances. Bibliography.

Diesel-Electric Plants

COSTS. Economics of the Use of Diesel Engines for Electric Power Generation, T. A. Burdick. *Oil and Gas Power (A. S. M. E. Trans.)*, vol. 52, no. 25, Sept.-Dec. 1930, pp. 65-74, 3 figs. Abstract of paper presented before Am. Soc. Mech. Engrs., previously indexed from Power, Sept. 16, 1930.

DESIGN. Further Refinement Characterizes Diesel Power. *Power Plant Eng.*, vol. 34, no. 24, Dec. 15, 1930, pp. 1425-1428, 3 figs. Refinement of engine construction, increase in use of auxiliary equipment, and improved plant management increase reliability of Diesel power; Diesel-plant data covering five central stations, six municipal plants, and five industrial applications; Diesel-engine data.

Electron-Theory

METALS. Some Recent Advances in the Electron Theory of Metals, R. H. Fowler. *Instn. Elec. Engrs.—Jl. (Lond.)*, vol. 68, no. 407, Nov. 1930, pp. 1469-1475, 3 figs. Nature of metal and classical theory; quantum mechanical revision; new conduction theory; thermoelectric effects; emission of electrons; magnetism and ferromagnetism; Kapitza's experiments on conductivity in strong magnetic fields.

Education

ENGINEERING. Summary of the Study of Technical Institutes, W. F. Wickenden. *Mgmt. (A. S. M. E. Trans.)*, vol. 52, no. 26, Sept.-Dec. 1930, pp. 63-69 and (discussion) 69-72. Previously indexed in Engineering Index 1929, p. 756, from Am. Soc. Mech. Engrs.—Advance Paper, for mtg. Dec. 2-9, 1929.

Broadening Effects of Engineering Education Demonstrated by Statistics, D. B. Prentice. *Mech. Eng.*, vol. 52, no. 12, Dec. 1930, pp. 1102-1103. Carnegie Foundation for Advancement of Teaching is making Elaborate study of secondary and collegiate education in Pennsylvania; important part is comprehensive examination in all fields of knowledge to measure content of students' minds; in spite of fact that more than half college course for engineers was devoted to professional subjects and many more hours to fundamental sciences, seniors possessed breadth of knowledge sufficient to score much higher in fields not their own than arts men.

Electric Circuits

Early Developments in A. C. Circuit Theory; Some Notes on the Application of Complex Methods to the Solution of A. C. Circuit Problems, G. Windred. *Lond., Edinburgh, and Dublin Philosophical Mag. and Jl. of Science (Lond.)*, vol. 10, no. 66, Nov. 1930, pp. 905-914. Neglect of theory in England is pointed out; theoretical mathematical analysis. Bibliography.

THREE-PHASE. Protection and Metering for Three-Wire Circuits, J. Auchincloss. *Power Plant Eng.*, vol. 34, no. 23, Dec. 1, 1930, pp. 1363-1366, 13 figs. Methods of locating faults in various circuits; two-phase five-wire with common protection; metering three-phase, three-wire and two-phase, four-wire power on one three element meter. (Concluded.)

Electric Discharge

NEON. Discharges in Neon, P. Johnson. *Lond., Edinburgh, and Dublin Philosophical Mag. and Jl. of Science (Lond.)*, vol. 10, no. 66, Nov. 1930, pp. 921-931, 4 figs. Following on researches which have been made at Electrical Laboratory, Oxford, on electric forces required to maintain high-frequency discharges in certain gases, author has undertaken measurement of these forces in neon.

TUBE FAILURE. A Note on the Fracture of Discharge-Tubes, R. H. Sloane. *Lond., Edinburgh, and Dublin Philosophical Mag. and Jl. Science (Lond.)*, vol. 10, no. 67, Dec. 1930, pp. 1099-1102, 1 fig. While investigating conditions of excitation near cathode of glow discharge in argon, inconvenience was experienced from frequent spontaneous failure of tubes, where discharges of only 2 milliamperes at 400 volts wire passed; apparently it is due partly to use of argon, which, as is well known, gives rise to heavy cathodic sputtering, but mainly to fact that design of tubes involved contact of cathode with walls.

Electric Furnaces

Electric Melting and Heating of Metals, W. S. Gifford. *Metal Industry (Lond.)*, vol. 37, no. 21, Nov. 21, 1930, pp. 481-484, 4 figs. Review of development and use of principal types of furnaces; Ajax Wyatt furnaces; arc furnaces; induction furnaces; high-frequency induction furnaces; refractory linings; resistance furnaces; factors controlling efficiency and operation with various metals. Paper read before mtg. of Manchester Assn. Engrs.

ANNEALING. Annealing Furnaces in the Metal Industry, Especially Modern Electric Furnace (Gluehoefen; besonders die neueren elektrischen, in der Metallindustrie), B. Schulz. *Brennstoff- und Waermewirtschaft (Halle)*, vol. 12, no. 17-18, Sept. 1-2, 1930, pp. 217-218, 2 figs. Electric annealing and heat-treating furnaces; equipment for heat-treating metal tubes and annealing of hoops, sheets, and wires.

HIGH FREQUENCY. Alloy Steel Melting in the Induction Furnace, O. Doerrenberg and N. Broglio. *Metallurgist (Supp. to Engineer, Lond.)*, Nov. 1930, pp. 166-167. Installation built at Ruenderoth has been in continuous day and night use, and at time of writing has been responsible for more than 1200 melts; furnace is energized by means of special generator capable of maintaining 1200 volts at frequency of 2000 cycles per sec.; tapered form of crucible has been adopted in spite of deliberate sacrifice of electrical energy implied by its use. Translated abstract of paper previously indexed from Stahl und Eisen, May 8, 1930.

Which do You Prefer?

LAST month we presented 73 of these references to current engineering literature, using large type; this month we present 115 items, using smaller type.

WHICH serves your purposes best? A PROMPT note to the Editor will be appreciated and will help to improve this reference service.

INDUCTION. Electrical Apparatus for the Coreless Induction Furnace, N. R. Stansel. *Iron and Steel Engr.*, vol. 7, no. 11, Nov. 1930, pp. 519-524, 15 figs.

Furnaces and accessories of 50 kw. and over are described in some detail; efficiency and temperature resistivity curves are given.

STEEL MAKING. High-Frequency Furnace Produces Pure Steel, R. Hohage and B. Matuschka. *Steel*, vol. 87, no. 24, Dec. 11, 1930, pp. 55-56. Type of furnace used by Schoeller-Bleckmann Steel Works, Vienna, Austria, has melting crucible made of acid refractory with coil wound around it; direction of current in coil is changed 3000 times per sec.; current is generated in separate high-frequency converter.

TRANSFORMERS. Transformers for Electric Furnaces (Les transformateurs pour fours électriques), G. Marty. *Jl. du Four Electrique (Paris)*, vol. 39, no. 10, Oct. 1930, pp. 378-380, 3 figs. Special characteristics, wiring diagrams of supply transformers with three regulating taps, one for continuous regulation. (To be continued.)

Electric Heating

MATERIALS. Tentative Methods of Chemical Analysis of Metallic Materials for Electrical Heating. *Am. Soc. Testing Matls.—Tentative Standards*, 1930, pp. 133-151, 2 figs. Outline of method covers; solutions required, determination of chromium, determination of manganese, determination of carbon, determination of insoluble residue, determination of silicon, determination of sulphur, determination of copper.

Electric Lines

ICE FORMATION. Currents Required to Remove Conductor "Sleet," J. E. Clem. *Elec. World*, vol. 96, no. 23, Dec. 6, 1930, pp. 1053-1056, 3 figs. Formula and alignment charts for calculating of preventing formation of ice; amperes required to prevent ice formation; current and temperature required to prevent sleet adherence; current and time required to melt ice; amperes required to melt off glaze.

Floodlighting

Short Cuts to the Solution of Floodlighting Problems, H. E. Butler. *Gen. Elec. Rev.*, vol. 33, no. 12, Dec. 1930, pp. 690-698, numerous figs. partly on supp. plate. Comments upon scope and tend of modern floodlighting; data for computation of floodlighting installations; sample problems; typical installations; summary of requirements; chart of floodlighting data and characteristics; partial list of athletic fields lighted with General Electric equipment.

Generators

ALTERNATING CURRENT. Flywheel Type Alternators in the Tropics, J. Finkelstein. *AEG Progress (Berlin)*, vol. 6. no. 12, Dec. 1930, p. 358, 1 fig. Description of AEG 860 kva., 6600 volt alternator for Dutch East Indies power station, Magelang, Java to work with airless injection 975 hp., 214 r. p. m., 6-cylinder 4-stroke cycle Diesel engine made by Messrs. Gebr. Sulzer, Winterthur.

Hydroelectric

POWER DEVELOPMENTS. Hydroelectric Utilizations in Irrigation Projects (Los Aprovechamientos Hidroelectricos en los Proyectos de Irrigacion), J. Herrera y Lasso. *Irrigacion en Mexico (Mexico, D. F.)*, vol. 1, no. 1, May 1930, pp. 22-26, 2 figs. How power development affects financing of irrigation systems; factors in study of probable power markets.

Illuminating Engineering

TERMINOLOGY. Revision of the American Standard Illuminating Engineering Nomenclature and Photometric Standards. *Illum. Eng. Soc.—Trans.*, vol. 25, no. 8, Oct. 1930, pp. 725-741. Activities and duties of Society's Committee on Nomenclature and standards; standard nomenclature, as revised to present time, is given.

Industrial Plants

ELECTRIC POWER. Economical Control of Purchased Electrical Power in the Industrial Plant, R. F. Gale. *Iron and Steel Engr.*, vol. 7, no. 21, Nov. 1930, pp. 536-537, 5 figs. Methods of obtaining high load factors by proper coordination of purchased and manufactured power used by Midvale Co., Philadelphia; day load peak 7500 kw. is approximately 3500 kw. greater than night load peak 4000 kw.

Insulating Materials

PAPER. Tentative Methods of Testing Untreated Insulating Paper. *Am. Soc. Testing Matls.—Tentative Standards*, 1930, pp. 571-589, 7 figs. Methods apply to untreated paper which is to be used as electrical insulator or as constituent of composite material used for electrical insulating purposes.

Properties, Tests and Applications of Papers in Electrical Industry (Propriétés, essais et applications des papiers en électrotechnique), A. R. Matthis. *Chimie et Industrie (Paris)*, Mar. 1930, (special no.) pp. 445-451. Properties required of such papers are briefly outlined, together with various tests to which they are subjected.

SLATE. Tentative Methods of Test for Determining the Insulating Qualities of Slate. *Am. Soc. Testing Matls.—Tentative Standards*, 1930, pp. 524-526. Method A covers determination of impedance leakage current flowing in high-voltage winding of transformer by means of ammeter in low voltage winding; method B covers determination of impedance leakage current flowing in high-voltage winding of transformer or specific ohmic impedance of slate by reading two voltmeters in low-voltage circuit.

TESTING. Tentative Methods of Testing Laminated Sheet Insulating Materials. *Am. Soc. Testing Matls.—Tentative Standards*, 1930, pp. 590-597, 1 fig. Tests apply to laminated flat sheet materials intended for use as electrical insulation.

Insulators

OIL-RESIN. Study of Electric Behavior of Oil-Resin Compounds with Special Regard to Range of Relatively Low Temperatures (Untersuchung ueber das dielektrische Verhalten von Oel-Harzimschungen unter besonderer Beruecksichtigung des Bereiches relativ geringer Temperaturen), E. Jirch and W. Riebel. *Archiv fuer Elektrotechnik* (*Berlin*), vol. 24, no. 4, Nov. 7, 1930, pp. 553-560, 11 figs. Relation between dielectric constants, angle of error and viscosity in range from 0 to 150 cent. at relatively low temperatures; phenomena are studied on theory of polar molecules of Debye.

PORCELAIN. Electrical Porcelain, J. K. Gillett. *Elecn.* (*Lond.*), vol. 105, no. 2737, Nov. 14, 1930, pp. 588-589, 5 figs. Tests for porosity; effect of glazes on mechanical and thermal properties; breakdowns caused by cementing. Bibliography. (Concluded.)

SPECIFICATIONS. British Standard Specifications for Porcelain Insulators for Overhead Power Lines. *Brit. Eng. Standards Assn.—Specifications* (*Lond.*), no. 137, 1930, 29 pp., 6 figs. Specification is applicable to porcelain insulators for overhead power lines at declared voltages and station voltages of 3 and 3.3 kv. respectively and upwards.

SUSPENSION. Suspension Insulators (Quelques remarques sur les isolateurs suspendux), Lequerier. *Société Belge des Electriciens—Bul. Mensuel* (*Brussels*), vol. 46, Nov. 1930, pp. 556-588, 10 figs. Comparison of types, characteristics, notes on testing and testing equipment, strength curves, high tension testing, arcing protection, etc.

TESTING. The European Insulator Situation, T. Rich. *Elec. Times* (*Lond.*), vol. 78, nos. 2037, 2039 and 2040, Nov. 6, 1930, pp. 787-788, Nov. 20, pp. 883-884, and Nov. 27, pp. 929-932, 14 figs. Notes on recent developments and on testing laboratories in particular; routine testing department and articles of equipment of two million volt laboratory of Rosenthal Works in Bavaria, previously indexed from various sources.

Lamps

GLOW. Gas Discharge Tubes in Television Practise (Die Gasentladungsroehren in der Fernsehtechnik), H. Ewest. *Fernsehen* (*Berlin*), vol. 1, no. 2, Feb. 1930, pp. 59-62, 3 figs. Characteristics of inertia free glow lamps and their suitability for television purposes outlined in general way; various types.

The Glow Lamp as Television Light Relay (Die Glimmlampe als Fernseh-Lichtrelais), F. Kirschstein. *Fernsehen* (*Berlin*), vol. 1, no. 11-12, Nov. 1930, pp. 495-501, 8 figs. Hysteresis of glow lamp is discussed; dynamic and static characteristic; a. c. characteristics, measurement of hysteresis; a. c. resistance as function of frequency; control of glow lamp by output tube, etc.

MANUFACTURE. Some Recent Developments in Lamp Manufacturing, J. A. Jones and E. I. Morwick. *Elec. News* (*Toronto*), vol. 39, no. 22, Nov. 15, 1930, pp. 39-40 and 48, 4 figs. Combination of ultra-violet and visible radiation gives promise of developing new era of lighting for health maintenance and general illumination; development of S-1 lamps, science has successfully limited wavelengths shorter than those usually found in sunlight; cut-off in natural sunlight is about 2800 A; spectrum of radiation, bulb transmission and response curves are given. (Concluded.)

Lighting

INDUSTRIAL. Current Industrial Lighting Practise, R. B. Brown, Jr. *Illum. Eng. Soc.—Trans.*, vol. 25, no. 8, Oct. 1930, pp. 716-724. Data and other information calculated to show modern trends in industrial lighting practise; facts and figures have been supplied by several lighting equipment manufacturers and illuminating engineers covering such items as variation in reflector sizes over period of years, as well as distribution of lamp sizes and types of reflector equipment most commonly used; present practise is shown from data supplied by several central-station lighting service engineers from which several definite conclusions are drawn.

VISION RELATIONSHIP. Lighting Plus Vision Equals Seeing, M. Luckiesh and F. K. Moss. *Illum. Eng. Soc.—Trans.*, vol. 25, no. 9, Nov. 1930, pp. 807-824 and (discussion) 824-825, 5 figs. Further attempts to interpret data on various relationships of fundamental factors of vision into lighting practice; scientific basis of satisfactory demonstrations of influence of lighting upon seeing is discussed and successful demonstrations are described and illustrated; various papers by authors represent series beginning with purely scientific data and proceeding, step by step, toward lighting practice.

Loud Speakers

Loudspeakers, S. G. Brown. *Elecn.* (*Lond.*), vol. 105, no. 2741, Dec. 12, 1930, p. 749. Critical discussion of paper on "Loudspeakers" Since Their Conception with Gramophone Pick-ups and Wireless Recording Apparatus, presented before Inst. Elec. Eng. Great Britain, in London.

An Efficient Loud Speaker at the Higher Audible Frequencies, L. G. Bostwick. *Acoustical Soc. Am.—Jl.*, vol. 2, no. 2, Oct. 1930, pp. 242-250, 5 figs. Purpose of this paper is to describe loud speaker by which it has been possible to obtain efficient radiation of these very high frequencies; this loud speaker is intended for use as adjunct to either baffle or horn type loud speakers to extend range of efficient performance to 11,000 or 12,000 cycles.

ELECTROSTATIC. Theory of the Electrostatic Loud Speaker, C. R. Hanna. *Acoustical Soc. Am.—Jl.*, vol. 2, no. 2, Oct. 1930, pp. 143-149, 2 figs. It is proved that force per unit voltage in electrostatic device is similar function of capacity and negative stiffness due to steady electrostatic field; new concept called Motional admittance is introduced for electrostatic loud speaker and this is shown to be similar in its mathematical form to Motional Impedance of electromagnetic driver; calculation of ultimate theoretical efficiency that may be obtained with electrostatic speaker having pure resistance radiator and covering given frequency range is given.

MEASUREMENT. Loud Speaker Sound Pressure Measurements, E. W. Kellog. *Acoustical Soc. Am.—Jl.*, vol. 2, no. 2, Oct. 1930, pp. 157-200, 18 figs. General test conditions and precautions; comparison of loud speaker system with direct listening; standing wave patterns; compensation for selective absorption in room; advantages of directive loud speakers; test information required to estimate merit; free space measurements; indoor test; moving microphone system; warble method; rapid frequency change method; close up tests; measurements of total output; experimental results; additional data needed; pressure and velocity in neighboroood of small simple source.

Magnetic Measurements

UNITS. New Electromagnetic Unit; One Oersted (En Ny Elektromagnetisk Enhed: En Oersted), A. W. Marke. *Ingenioren* (*Copenhagen*), vol. 39, no. 45, Nov. 8, 1930, pp. 537-539, 1 fig. International Electrotechnical Commission, in meeting at Copenhagen in June 1930, approved new absolute unit for intensity of field and called it "one oersted;" events leading up to this decision and physical definition of unit.

Remarks on the Decisions of International Electrical Commission with Regard to Magnetic Units (Observations sur les décisions de la Commission électrotechnique internationale concernant les unités magnetiques), E. Brylniski. *Revue Générale de L'Electricité* (*Paris*), vol. 28, no. 19, Nov. 8, 1930, pp. 722-725. Author concludes that reserves made by Kennelly with respect to use of prefix "Pra" for practical units are without ground as units so characterized can leave no room for doubt.

Metering

The Metering of Three-Phase Supplies, O. Howarth. *Instn. Elec. Engrs.—Advance Paper*, 1930, 13 pp., 13 figs. Large bulk supplies are most complex and demand high standard of accuracy for commercial reasons; unfortunately, each additional complexity introduces additional source of error, and inaccuracies introduced by auxiliary apparatus and special fitments are discussed.

Meters

Summation Metering Equipment. *Engineer* (*Lond.*), vol. 150, no. 3908, Dec. 5, 1930, pp. 628-629, 6 figs. Ferranti equipment is described: diagram shows equipment required for summation metering of complete station having two-way transformer circuits, three generators, and station auxiliary machine; mechanism consists of two-way contactor driven by auxiliary spindle geared to main meter spindle, and is fitted with heavy silver contacts moved positively in each direction by jewelled rollers bearing on cam.

FREQUENCY. A New Frequency Meter, C. L. Lipman. *Elec. Rev.* (*Lond.*), vol. 107, no. 2763, Nov. 7, 1930, pp. 793-794, 4 figs. New deflectional-type instrument for measurement of power frequencies.

Mining

ELECTRIC EQUIPMENT. New Mining Electrical Control Gear. *Engineer* (*Lond.*), vol. 150, no. 3905, Nov. 1930, pp. 546-547, 8 figs. For use in mines, Metropolitan-Vickers Electrical Co., has introduced some new control gear, including self contained controller; mining switch units, also supplied as gate end boxes and mining transformer units; and plug distribution boxes.

ELECTRIC HAZARDS. Selected List of Bureau of Mines Publications Covering Safety Studies and Activities of the Electrical Section, L. C. Ilsley. *Coal Min.*, vol. 7, no. 10, Oct. 1930, pp. 489-491. Previously indexed from U. S. Bur. Mines—Information Cir., no. 6310, July 1930.

Motors

INDUCTION. Motor Selection Improves Power Factor, L. F. Leurey. *Elec. West.* vol. 65, no. 6, Dec. 1, 1930, pp. 292-295, 3 figs. Conclusions are that induction motors should be selected with highest possible speed consistent with practical gear reduction; and operated at highest possible percentage of rated capacity; this especially applies to wound rotor motors intended for variable speed operation.

INDUCTION—STARTING. Use of Induction Motors with Short Circuited Rotor (Sur l'emploi des moteurs asynchrones en court-circuit), J. Le Monnier. *Revue Générale de l'Electricité* (*Paris*), vol. 28, no. 20, Nov. 15, 1930, pp. 771-779, 9 figs. Squirrel cage motor is only one case of short-circuited rotor type; starting of Boucherot double cage motor; starting of simple motor; experimental verification of starting characteristics; starting current diagrams; braking; influence of power factor; starting by insertion of resistance or inductance in stator circuit.

SYNCHRONOUS. Synchronous Motors, A. H. v. Altmann. *AEG Progress* (*Berlin*), vol. 6, no. 12, Dec. 1930, pp. 366-371, 4 figs. Characteristics of synchronous motors: overload and fluctuations in torque; network voltage fluctuations; network frequency fluctuations; advantages over other machines; starting methods.

Networks

INTERCONNECTED. Power Flow Studies in Interconnected Systems, P. B. Juhnke. *Gen. Elec. Rev.*, vol. 33, no. 12, Dec. 1930, pp. 670-673, 6 figs. For purpose of helping such study, series of diagrams were constructed for Chicago District for different periods and seasons of immediate years ahead, and for peak periods even decade in advance; four systems involved are operating as one system, by virtue of Interchange Energy Contract, and comprise what is commonly known as Chicago Regional System.

STABILITY. Power-System Stability, R. D. Booth and O. G. C. Dahl. *Gen. Elec. Rev.*, vol. 33, no. 12, Dec. 1930, pp. 677-681, 1 fig. Comprehensive and non-mathematical review of stability problem; review of general problem of power-system stability in light of present knowledge; aspects which still are in controversial and unsettled state as, for instance, effect of damper windings, and influence of various methods of grounding high-tension neutral points. (To be continued.)

Power Factor

CORRECTION. Improvement of Power Factor. *Elec. Times* (*Lond.*), vol. 78, no. 2040, Nov. 27, 1930, pp. 937-939, 7 figs. Use of electrostatic condensers for correction of low power factors.

Power Generation

Balance Between the Supply and the Consumption of Energy, R. W. Miller. *Elec. Engr. of Australia and New Zealand* (*Melbourne*), vol. 7, no. 7. Oct. 15, 1930, pp. 235-240, 2 figs. Main factors which affect cost of electrical energy and means that can be adopted to effect economies; basic problem arises from fact that electricity cannot be stored, and therefore various expedients have to be adopted in adjusting supply to cope with demand; it is shown how hydroelectric storage plants may be used to level up demand on base load stations; modern developments in steam power station practice. (To be concluded.)

Power Industry

Congress of the International Association of Producers and Distributors of Electric Power in Brussels, September 1930 [Congrès de Bruxelles de l'Union internationale des Producteurs et Distributeurs d'Energie électrique (Septembre 1930)]. *Revue Générale de Electricité (Paris)*, vol. 28, nos. 20 and 21, Nov. 15, 1930, pp. 765-770 and Nov. 22, 1930, pp. 803-812. Discussions on reported improvements in equipment of thermal generating stations in Belgium, Argentina and Italy; interconnection of metallurgical plants in Briey region; unification of frequencies; smoke abatement, etc.

Power Supply

RURAL. The Status of Research in Rural Electrification, G. W. Kable. *Elec. Jl.*, vol. 27, no. 12, Dec. 1930, pp. 705-707. Since beginning of organized research in 1923, 24 states have undertaken investigational programs; primary purpose of these surveys has been to learn something of use, demand, cost, and value of electric service on farm, and fundamental difficulties involved in extension of this service; in order to have satisfactory uses for electricity on farm.

Photoelectric Cells

Photo-electric Cells, T. Thorne Baker. *Elec Rev. (Lond.)*, vol. 107, no. 2763, Nov. 7, 1930 pp. 768-769, 3 figs. Circuit with one-valve amplification; bridge circuit for lamp photometry; automatic lighting controller. (Concluded.)

SELENIUM. The Selenium Cell; its Properties and Applications, G. P. Barnard. N. Y., Richard R. Smith, Inc., 1930, 331 pp., illus., diagrs., $9.00. Valuable monograph aims to present precise, accurate survey of knowledge of properties of selenium and of applications of selenium cells to photophony, television, talking films and other practical uses; scattered literature has been very thoroughly summarized and exhaustive bibliography is included in book, which will be found most useful by all workers n this field. Eng. Soc. Lib., N. Y.

Power Plants

PEAK LOADS. Storing Power for Peak Loads, W. H. Onken, Jr. *Nat. Elec. Light Assn.—Bul.*, vol. 17, no. 12, Dec. 1930, pp. 759-761 and 800, 4 figs. Practices of European electric power system in utilizing stored steam and pumped water for auxiliary power during peak loads or in emergencies.

STEAM AND DIESEL. Diesel Power—With Steam Combination. *Power*, vol. 72, no. 22, Nov. 25, 1930, pp. 842-845, 3 figs. Diesel hook-ups shown range from simplest to more complex, former being more typical of current practice; for given power output diesel receives and rejects less heat; however, methods and equipment for conserving waste heat are available wherever economic conditions justify their use.

STEAM AND HYDROELECTRIC. Steam and Hydro Combined for Power and Process. *Power*, vol. 72, no. 21, Nov. 18, 1930, pp. 786-790, 5 figs. Dalhousie plant of New Brunswick International Paper Co. is typical of interrelation of water-power development and paper industry in Canada; 6000-kw. steam turbine and 425-lb. boilers for process steam and emergency service insures reliable operation of 570-ton paper mill when hydro power is obtained over single 110-mi. transmission line; sectional elevation and principal equipment in power plant.

Railroads

POWER SUPPLY. Supply Lines for Single Phase Railroads (Speiseleitungen von Einphasenbahnen), E. Wist. *Elektrotechnik und Maschinenbau (Vienna)*, vol. 48, no. 43, Oct. 26, 1930, pp. 970-972, 1 fig. Analysis of requirements and economical relations between plant, lines and networks; numerical example of 100 kv. line of 240 sq. lines and networks; numerical example of 100 kv. 100 km. line of 240 sq. mm. cross-sectional area for 33,000 kw.

SUBSTATIONS. Omaha Changes Power System To Raise Speed. *Traction Shop and Roadway*, vol. 3, no. 11, Nov. 1930, pp. 327-329, 4 figs., see also *Elec. Traction*, vol. 26, no. 11, Nov. 1930, pp. 566-568, 4 figs. Installation of nine automatic substations, installed throughout system of Omaha and Council Bluffs street railway, eliminate steam power plant, retire old cars and raise average car speed.

Rectifiers

COPPER OXIDE. Copper Oxide Rectifiers, K. Singh and I. R. Smith. *Elec. Times (Lond.)*, vol. 78, no. 2041, Dec. 4, 1930, pp. 975-979, 11 figs. Some consideration of their properties and their electrochemical action in general; actual characteristics and applications of copper oxide rectifiers in practice.

Radio

BROADCASTING. The Importance of Phase Control in Synchronizing, C. W. Horn. *Electronics*, vol. 1, no. 9, Dec. 1930, p. 423. Results of experiments carried out with cooperation of National Broadcasting Co., Radio Corporation of America, and American Telephone and Telegraph Co.; experimenting stations were maintained not only at same frequency but in fixed phase relation, several important and encouraging events transpired, no longer was program coming to local listeners disturbed, much area disappeared and those listeners in this area experienced increase in local field strength.

DETECTORS. Some Properties of Grid Leak Power Detection, F. E. Terman and N. R. Morgan. *Inst. Radio Engrs.—Proc.*, vol. 18, no. 12, Dec. 1930, pp. 2160-2175, 8 figs. It is shown theoretically that grid power detection can be obtained without undue distortion provided grid condenser reactance to modulation frequency, and grid leak resistance are related to degree of modulation in definite way; load limit of grid-leak power detector is point where plate rectification becomes appreciable, i. e., when straight line part of plate characteristic is exceeded; experimental results are given which verify theoretically determined point at which distortion becomes excessive.

Radio Frequency

STANDARDS. An International Comparison of Frequency by Means of a Luminous Quartz Resonator, S. Jimbo. *Inst. Radio Engrs.—Proc.*, vol. 18, no. 11, Nov. 1930, pp. 1930-1934, 1 fig. International comparison of frequency standards made with luminous quartz resonator shows different laboratories to be in agreement to one part in 100,000 when used to calibrate resonator at its flexual fundamental of about 10 kc.; observed agreement seems limited by luminous glow resonator used rather than by any difference between laboratory standards compared.

Relays

Theory and Application of Relay Systems, P. H. Robinson and I. T. Monseth. *Elec. Jl.*, vol. 27, no. 12, Dec. 1930, pp. 720-726, and 728, 13 figs. Transmission line protective relays; nine major types of protective relays are used; after fundamental characteristics of these are fixed in mind, it is easy to remember combination of types used to give complete selective protection to particular arrangement of transmission lines; various types are discussed. (To be continued.)

Ship Propulsion

ELECTRIC. Wider Use of Electric Power for Propelling Ships, D. W. Niven. *Mar. Rev.*, vol. 60, no. 12, Dec. 1930, p. 43. Review of growing application of electric power to ship propulsion.

Telegraph Systems

Developments in Machine Telegraph Systems and Methods of Operation, H. H. Harrison. *Instn. Elec. Engrs.—Jl. (Lond.)*, vol. 68, no. 407, Nov. 1930, pp. 1369-1453 and (discussion) 1453-1468, 141 figs. Speed and phase control; definition of synchronism; motor speed control; governors; phase control; methods of generation of correction impulses; control of tuning-fork speed and phase by line signals; start-stop synchronism; local synchronism; general principles of synchronizing schemes; speed and phase indicators; phase adjustment or orientation; tuning forms; phonic-wheel motors; distributor construction and speed; rates of vibration of tuning of forks. Bibliography.

Telephone

CARRIER CURRENT. Function of Repeating Coils in Carrier Circuits, A. G. Ganz. *Bell Laboratories Rec.*, vol. 9, no. 3, Nov. 1930, pp. 134-136, 2 figs. Lack of metallic connection assists in keeping stray noise-producing voltages, picked up by line and transmitted longitudinally, from passing through terminal circuits; repeating coil also allows less-expensive unbalanced apparatus to be used without disturbing balance of line wires to ground.

TESTING. Comparative Transmission Tests, B. C. Burden. *Telephone Engr.*, vol. 34, no. 11, Nov. 1930, pp. 23-27, 6 figs. Notes on practical methods of testing efficiency of subsets, transmitters, and receivers; practical application of DB; transmission losses; transmission factors; loop losses; transmission loss due to eavesdropping on multi-party lines; transmission loss in central office equipment; transmission efficiency of subsets; transmission losses due to improper use of instruments; transmission losses in trunk plant; transmission testing circuits for determining instrument efficiency.

Telephone Relays

MAGNETIC INTERFERENCE. Effect of Magnetic Interference on Relay Operation, W. Buhler. *Bell Lab. Rec.*, vol. 9, no. 3, Nov. 1930, pp. 110-114, 5 figs. Part spreads out and returns to back end of core over longer path through air; any iron in vicinity due to its high permeability would become likely path for this stray flux to follow; because of this cores and armatures of nearby relays often serve to conduct stray flux; magnetic flux, which causes pull.

Television

Photoelectric Cells, Scanning Discs, Tiny Motors and Tube Current Meters, New Tools for Research, E. L. Manning. *Projection Eng.*, vol. 2, no. 11, Nov. 1930, pp. 20 and 24. Notes on equipment used in public television demonstration in Schenectady in which complete vaudeville program was transmitted 2 miles away from theater where it was presented.

Trackless Trolleys

DETROIT. Trolley Bus Operation Proves Advantageous at Detroit. *Elec. Ry. Jl.*, vol. 74, no. 13, Dec. 1930, pp. 753-754, 3 figs. Decreased operating costs, increased traffic, improved public relations, and almost entire freedom from accidents are advantages of trolley bus operation on Plymouth Road, Detroit.

GERMANY. Electric Trolley Bus Line Mettmann-Gruiten (Der elektrische Fahrdragtbus-Betrieb Mettmann-Gruiten), A. Schiffer. *Verkehrstechnik (Berlin)*, no. 38-39, Sept. 19, 1930, pp. 501-505, 5 figs. First modern electric trolley-bus line in Germany of Rheinisch-Westfaelische Elektrizitaetswerk, Essen; line of 5.77 km. total length is very much curved and only .86 per cent horizontal, rest is distributed over gradings from 1 to 10 and 1 to 30 inclinations; equipment described is run by 89 kw. 1425 r. p. m. at 750 to 800-volt d. c.; gear ratio 1:11.8.

Transmission and Distribution

Generation, Transmission and Distribution, H. R. Woodrow. *Power Plant Eng.*, vol. 34, no. 24, Dec. 15, 1930, pp. 1415-1418, 3 figs. Developments in electric systems process indicates improved network protection, development of vertical a.c. networks, better cable design and larger generators.

Vacuum Tubes

DETECTOR. The Estimation of the Sensitivity of the Grid Rectifier for Large Inputs, C. D. Hall. *Experimental Wireless (Lond.)*, vol. 7, no. 87, Dec. 1930, pp. 668-670, 5 figs. Measurements on sensitivity of grid rectifier using low impedance valves of "L" type with high anode voltages followed by resistance coupling; when practical results were compared with theoretical curve, former showed much smaller output than latter; as result of experiment, it was found to be due to small time constant or grid condenser and leak circuit.

Welding

ALLOY STEEL. Welding of Corrosion Resisting Steels, W. Spraragen. *Welding*, vol. 1, no. 14, Dec. 1930, pp. 979-980 and 985, 5 figs. General instructions covering welding technique used in arc welding, gas welding, resistance welding, and welding with shielded arc.

ARC. Significance of Welding of Depth in Arc Welding and Means for Improving (Die Bedeutung der Einbrandtiefe beim Lichtbogenschweissen und die Mittel zu ihrer Verbesserung), E. Schwartz. *V.D.I. Zeit. (Berlin)*, vol. 74, no. 46, Nov. 15, 1930, pp. 1565-1567, 13 figs. Factors controlling welding depth in d.c. arc welding; importance of welding depth for different types of joints and materials.

BOILERS. Welded Boiler, J. C. Hodge. *Mar. Eng. and Shipp. Age*, vol. 35, no. 12, Dec. 1930, pp. 652-658, 13 figs. Bureau of Engineering, U. S. Navy, has adopted arc-welded construction for joints of drums for 24 boilers now being built by Babcock & Wilcox Co., for new scout cruisers Minneapolis, New Orleans and Astoria; specifications drawn up are based on proposed specifications for fusion welding of drums or shells of power boilers published by A.S.M.E. boiler code committee; specifications governing test procedure.

BRONZE. Bronze Welding of Steel and Cast Iron, T. D. Ketchbaw. *Welding*, vol. 1, no. 14, Dec. 1930, pp. 981-985, 4 figs. General technique and property of bronze welds with particular reference to welding of locomotive frames and cylinders; tensile strength of bronze weld, properly made is around 50,000 lb. per sq. in.

BUILDINGS. Arc Welding on Steel Buildings, F. P. McKibben. *Civil Eng.*, (*N. Y.*), vol. 1, no. 3, Dec. 1930, pp. 205-206. Discussion by F. T. Llewellyn, H. M. Priest, J. L. Faden and S. H. Widdicombe of paper indexed from issue of Oct. 1930.

MACHINERY. Electric Welding and its Applications in the Manufacture of Electric Machinery (La soudure électrique et ses applications dans la construction des machines électriques), Taphanel and Weber. *Revue d'Electricité et de Mécanique* (*Paris*), no. 13, Sept.-Oct. 1930, pp. 19-34, 34 figs. General notes on possibilities of electric welding; welding applied in electric manufacture plant construction illustrated by welded structures in France and of General Electric Plant in Philadelphia; applications of welding in machinery and equipment manufactured by Als. Thom. Co.

PIPE. Fusion Welding Specifications for Steel and Wrought Iron Pipe, J. H. Zink. *Welding*, vol. 1, no. 14, Dec. 1930, pp. 975-978, 7 figs. Specification adopted by Heating & Piping Contractors Assn. as to workmanship, design, and materials; single vee type joint; tables and sketches give data on beveling, spacing and tacking; fillet welds; welding neck flanges; tube turns; swages or reducers; dimensions and shapes of tee and angle joints.

PIPE LINES. Arc Welded Pipe Lines for Steam and Water Service, C. M. Taylor. *Plumbers and Heat. Contractors Trade Jl.*, vol. 89, no. 12, Dec. 15, 1930, pp. 17-18, 8 figs. Advantages of electric welding outlined with directions on how joints, reducers and plugs are to be made.

REPAIR SHOPS. Railroad Shops Save by Welding, J. C. Coyle. *West. Machy. World*, vol. 21, no. 11, Nov. 1930, pp. 489-491, 9 figs. Methods at Denver locomotive shops of Burlington railroad for repairing cylinder cracks, worn cross-heads, stoker screw, broken bolts, patching of fire-boxes, etc.; data on savings.

Welding Machines

Heavy Duty Butt Flash Welding Machines. *Engineer* (*Lond.*), vol. 150, no. 3905, Nov. 14, 1930, p. 540. Extensive trials having shown that butt welding is satisfactory for certain purposes and that quality of weld may be equal to that of solid material, method is now widely adopted in railway works, shipyards, etc.; A.E.G. of Berlin, has designed machines in which clamping device is accessible on all sides and in which transformer is water cooled.

Development of Welding Equipment According to Langmuir Process in America and Germany (Die Entwicklung der Schweissgeraete nach dem Langmuir-Verfahren in Amerika und Deutschland), S. Sandelowsky. *Elektrotechnische Zeit.* (*Berlin*), vol. 51, no. 58, Nov. 27, 1930, pp. 1649-1652, 11 figs. Electric equipment, transformers, etc., of arc atom welding process of General Electric Co. and development of same equipment at AEG; voltage protection.

Welds

TESTING. A Study of Welded Metals Under Fatigue Tests, G. E. Thorton. *Am. Welding Soc.—Jl.*, vol. 9, no. 10, Oct. 1930, pp. 48-66, 14 figs. Testing procedure and results obtained by Department of Mechanical Engineering of State College of Washington, in cooperation with American Bureau of Welding; sketch illustrates construction of Farmer type rotating beam testing machines; graphs and tables give data on properties of oxyacetylene weld, atomic hydrogen weld, metal arc weld; microphotograph illustrates crystal structure in weld and parent metal.

Tensile Tests for Welds, J. W. Owens. *Am. Welding Soc.—Jl.*, vol. 9, no. 10, Oct. 1930, pp. 79-88, 7 figs. Suggestions relating to standard A.S.T.M. tensile test specimens now used for fusion butt welds; sketches illustrate development of suitable shape of tension specimen to determine fusion and value of weld as joint; results of tests obtained with weld metal of high tensile strength and fair ductility.

Wiring

OFFICE BUILDINGS. Specifications for Electric Power Requirements in a Moderate Sized Office Building, J. C. Runyon. *Elec. Specifications*, vol. 2, no. 6, Dec. 1930, pp. 27-34. Sample specifications of moderate size office building of from 100,000 to 200,000 sq. ft. floor area. (To be continued.)

Electrical Installation in the Moderate Sized Office Building, F. Latzer. *Elec. Specifications*, vol. 2, no. 6, Dec. 1930, pp. 17-22 and 39, 7 figs. Lighting system layout of Park Building, Yonkers, N. Y. is described in detail; notes on metering; construction details; wiring devices; power system; service details; signal system.

Employment Notes

Of the Engineering Societies Employment Service

Positions Available

PHYSICIST OR ENGINEER to carry out research and testing on electric meters. Apply by letter only, stating age, race, nationality, education, technical experience and references. Location, Canada. W-2153.

MECHANICAL ENGINEER, Polish, with long experience in electric furnace castings. Must be conversant in tempering and forging works. Apply only by letter. Location, Europe. W-1920.

CHIEF OF ELECTRICAL INSTRUMENT ENGINEERING for manufacturer of electrical apparatus. It is essential that the applicant be able and willing to fit into an old and closely knit organization; that he be thoroughly familiar with the mathematical methods of instrument design, and that he have a knack and a liking for small mechanisms. While the financial return will be based on results and will eventually be adequate the attractiveness of this opening lies in the opportunity for real engineering achievement. Apply only by letter. Location, New York. W-2209.

Men Available

ELECTRICAL ENGINEER, 36, single, European education, North American training, good executive, nine languages. Eight years' experience, construction, maintenance; operation large public utility plants. Seven years' sales experience, various branches, expert in exports and government supplies, traveled over the world. Adaptable to any country, climate. Available now. Desires position abroad. C-8351.

GRADUATE ELECTRICAL ENGINEER, 1929, 22, single; 15 months on General Electric test course. Desires position with utility or manufacturing company or with concern doing consulting or construction engineering. Available immediately. Location, New England preferred. C-8028.

PUBLIC UTILITY ENGINEER, college graduate, class 1925. Married. Five years' general engineering experience on distribution and transmission work. Also wide construction experience, maintenance and operating supervision, appraisal, valuation, right-of-way, forecasting future load, commercial and power sales work, etc. Location, immaterial. C-4001.

GRADUATE ELECTRICAL ENGINEER, 26, single, 10 years' experience in motion picture projection; one year radio. Desires connection with concern interested in production end of motion pictures or television. Location, immaterial. Future behind position controlling factor. C-7934.

ELECTRICAL ENGINEER, 40, with mining, steel, and general industrial experience, available at once. Four years' in technical publishing, editorial capacity. Interested in research and development work, plants and processes, industrial investigations and financing plant operations, or general engineering. East preferred. B-4905.

GRADUATE ELECTRICAL ENGINEER, B. S. degree, one and a half years with large electrical manufacturing concern in test and research departments; also familiar with repair work on distribution transformers and other apparatus. Available on short notice. Location preferred, New England or eastern part of country. C-8075.

ELECTRICAL ENGINEER, graduate, 33, married. Twelve years' experience, last six years in Latin America; for four years designed electrical machinery; five years public utilities, planning, design, supervision of construction of power plants and substations, three years chief electrical engineer raw sugar factory; fluent Spanish. Available February. Location preferred, New York City, vicinity. C-8553.

GRADUATE ELECTRICAL ENGINEER; 17 years' experience in electrical manufacturing; electric railway, power plant, substation and transmission line design and construction, desires connection with real opportunity. C-8256.

ELECTRICAL ENGINEER, university graduate, age 29, married. Seven years' varied experience in electrical design, purchasing and estimating for large power plant work. Also industrial, theater, apartment and office building experience with contracting engineers. Field and office. Desires position with engineering or contracting organization. Location preferred in the East. B-7454.

ELECTRICAL ENGINEER, 31, B. S.-E. E., 1926. One year as assistant electrical engineer making preliminary studies, investigations on hydroelectric projects; one year engineer, electrical control of armament on aeroplanes; two years car, material inspector, street railway company; one year student engineer large public utility; two years' electric car shop experience. C-6077.

INSTRUCTOR, graduate E. E. of a grade A European University and M. S. of a Southern University. Two years' teaching experience. Best references. Available June 1, 1931. Location, immaterial. C-8580.

COLLEGE GRADUATE, B. S. degree, Wesleyan University, 1924, in electricity, physics, mathematics. One year electrical test, meters. Six years electrician, power and light manager, estimating. Desires position as junior engineer in laboratory. Would consider position as chief electrician in manufacturing plant. Location, East. Available immediately. C-4294.

GRADUATE ELECTRICAL-MECHANICAL ENGINEER, 36, desires connection with public utility or industrial firm on power-station operation as engineer, or assistant to superintendent or engineer. Ten years' experience power-plant test, operation, design, construction, maintenance. Three years' electrical engineer for industrial concern. Two years assistant to power engineer. B-8379.

ASSISTANT EXECUTIVE, 39, married, technically trained. Connections with large public utility, manufacturers, and industrial consultants on work of administrative and commercial research nature. Especially qualified as assistant to busy executive needing man with management ability. Well endorsed. Prefer East. B-9122.

ARMATURE WINDER, 18 years' shop experience. Capable of handling all kinds of electrical motor repairs up to 250 kw. either a-c. or d-c., able to do all kinds of windings, old or new styles. Familiar with wiring for light and power. Desires position in shop or as electrician maintaining factory or office building. C-7952.

ELECTRICAL ENGINEER, graduate, 36, married. Twelve years' experience; last five years with very active consulting engineer. Design, writing specifications and requisitions, cost estimates, industrial surveys, supervision of electrical installations covering new and extensions to existing power houses and industrial plants. Valuable to consulting engineer or industrial concern. Available at once. C-343.

1929 GRADUATE ELECTRICAL ENGINEER, age 24, with year and half experience in manual and dial telephone work. Prefers work in radio or sound reproduction. Location in or near Maryland preferred. Available on short notice. C-8581.

ELECTRICAL ENGINEER, Bachelor's and Master's degrees; fourteen years peculiarly broad experience in test, research and development, standardization, consultation, university teaching, executive work, personnel; familiar with both power and radio equipment and practise. Stability and opportunity primary, initial salary and location secondary. Available at once. C-4951.

DEVELOPMENT ENGINEER, 29, with exceptional abilities for electrical relay circuits, as supervisory, remote or automatic control, automatic telephony, alarm systems, etc. Solves circuit problems with minimum of equipment (relays, contacts) and in record time. Also resourceful in small apparatus design. University graduate. At present employed. Desires connections with larger company. C-8373.

GRADUATE ELECTRICAL ENGINEER, 27, married. Seven years' test and laboratory experience with large electrical manufacturing company. Desires position as electrical engineer with manufacturing company or public utility. C-8592.

JUNIOR ENGINEER, 25, single. Desires connection with public utility, sound picture industry or radio manufacturing firm. General Electric test course, public utility distribution test experience. Test, design, construction, maintenance and engineering work in radio receiver manufacturing plant. Location, East. C-8596.

GRADUATE ELECTRICAL ENGINEER, age 29, married. Five years' maintenance and construction work. Three years's design, test and service work on distribution and power transformers. Also some sales experience. Interested in position with mining, public utility company or industrial concern. Reasonable salary with company offering opportunity. C-8539.

GRADUATE ENGINEER, 21, single, graduate in electrical engineering with B. S. degree. Twelve months' experience on electric meters. Desires position with opportunity for advancement with utility, manufacturing, or other engineering concern. Location preferred, New York or vicinity. C-8387.

ELECTRICAL ENGINEER, 30, married, B. S. in E. E. graduate student course, Westinghouse; substation construction from handling the tools to field engineer; cost keeping and material handling in construction department. Last two years substation and underground vault design. Additional education; business finance, Geneva College; Business management, La Salle; system stability, Westinghouse. C-8572.

ELECTRICAL ENGINEER, 24, married. Experience with oscillographs, vacuum tube amplifiers, and portable wireless sending and receiving set. Has done test work for utility. Also surveying experience. Holds second grade commercial wireless operators license. C-3035.

VALUATION ENGINEER, all phases of complete valuatious; to take charge or do anything else, electrically trained. Accounting experience. C-234.

GRADUATE ELECTRICAL ENGINEER, 27, married. Six years' experience in substation and generating station design with middle western utility. Two years' graduate study in utility economics. Technical writing experience. Available on three weeks' notice. C-1331.

ELECTRICAL ENGINEER, B. S. degree, Iowa State College 1929, 26, married; now employed. Has had one year experience in physical testing laboratory of Western Electric Company. Desires position in the radio or electrical industries with opportunity for advancement. Location preferred, Middle West. Available on two weeks' notice. C-8632.

GRADUATE ELECTRICAL ENGINEER, 31, single. Previous to college education, 8 years' experience as a licensed electrician. Now teaching physics and mathematics in Springfield, Massachusetts. C-8633.

RESEARCH ENGINEER, exceptional theoretical and research grounding. Thoroughly familiar with commercial instruments. Two years' public utility engineering. Three and one-half years' responsible executive and development experience in highly specialized technical industry. Prefer small corporation in United States. Best references and connections. C-6938.

GRADUATE ELECTRICAL ENGINEER, experienced on testing, developmental manufacturing, electrical plant construction, wide experience all features design of power stations, indoor and outdoor substations, and industrial light and power. Checker two years. Squad leader two years. Will consider any location. B-9222.

ELECTRICAL ENGINEER, single, 30, Scandinavian, graduate Swiss Federal Institute of Technology, Zurich, with 6½ years' experience, four of them in United States, with manufacturing, mining, public utility and sugar companies, including operation, test, layout, estimate, inspection, drafting and design. Desires permanent position with future. Speaks German and Spanish. C-3764.

ELECTRICAL DESIGNER AND DRAFTSMAN, age 31, single. Eight years' public utility experience in steam and hydroelectric plants, substations and industrial plants. Graduate of technical school in mechanical and electrical engineering. Desires position with public utility or industrial company. C-4510.

RESEARCH ENGINEER, 27, Westinghouse graduate engineer, United States citizen, married, returning from two and one-half years of graduate study in Germany. Desires position for fundamental research in physics or in electrical engineering with an industrial organization; location preferred, Eastern United States. C-8642.

PYROMETER ENGINEER, 25 years of age, christian, single. Graduate of electrical engineering extension course of Columbia University. Have had five years' experience as a field engineer for a well known manufacturer of industrial instruments. Experienced in the construction, application and selling of pyrometers and automatic valves. C-8647.

GRADUATE ELECTRICAL ENGINEER, 1930. Seven months' experience in electrical substation layouts with a public utility. Desires related position in drafting or testing. Age 22. C-8293.

GRADUATE ELECTRICAL ENGINEER, 35, married. Twelve years' experience of which five as junior executive, with street railway, power and light utilities. Qualified for position as assistant general executive or in transmission

ENGINEERING SOCIETIES EMPLOYMENT SERVICE

57 Post St. San Francisco N. D. Cook, Manager	205 West Wacker Drive Chicago A. K. Krauser, Manager	31 West 39th St. New York W. V. Brown, Manager

MAINTAINED by the national societies of civil, mining, mechanical, and electrical engineers, in cooperation with the Western Society of Engineers, Chicago, and the Engineers' Club of San Francisco. An inquiry addressed to any of the three offices will bring full information concerning the services of this bureau.

Men Available.—Brief announcements will be published without charge; repeated only upon specific request and after one month's interval. Names and records remain on file for three months; renewable upon request. Send announcements direct to Employment Service, 31 West 39th Street, New York, N. Y., to arrive not later than the fifteenth of the month.

Opportunities.—A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

Voluntary Contributions.—Members benefiting through this service are invited to assist in its furtherance by personal contributions made within 30 days after placement on the basis of 1.5 per cent of the first year's salary.

Answers to Announcements.—Address the key number indicated in each case and mail to the New York office, with an extra two-cent stamp enclosed for forwarding.

or distribution department. Desires position with United States utility. Good references. Available immediately. C-5091.

DISTRIBUTION ENGINEER, 32, married. Six years' utility experience. Thoroughly familiar with organizing for economical maintenance, servicing, and construction, including records, accounting, reports. Some experience, steam power plant equipment, testing. Cornell University E. E. 1923. Now employed, junior executive on engineering and construction. Open for more responsible position, preferably in operating. C-5155.

ELECTRICAL ENGINEER, 37, married. Graduate from a German University. Fourteen years' experience in designing overhead and underground distribution lines, substations, and power and light distribution for industrial plants. Available at once. C-8648.

SOUND ENGINEER, 26, graduate E. E. One and one-half years recording engineer on talking motion pictures, 1½ years on audio amplifier design, remote control radio systems and public address systems. Thoroughly experienced on home recording apparatus. Available immediately. Location, New York and vicinity. C-4407.

CHINESE ELECTRICAL ENGINEER, Cornell graduate, M. M. E., G. E. test. Two years' public utility, nine years' power plant engineering experiences with leading American concerns, has great acquaintances among Chinese engineering circles, seeks connections with American manufacturers having interests in China. Location preferably, Shanghai, B-5548.

PROFESSOR OF ELECTRICAL ENGINEERING, 40, six years' successful experience teaching practically all branches electrical engineering, state school. Considerable experience power, telephone work. One year switchboard engineering department of Westinghouse. B. S. in E. E. and E. E. degrees. Prefer location, Rocky Mountain, Pacific Coast States. Available school year 1931-1932. C-5021.

ELECTRICAL, MECHANICAL ENGINEER, college graduate with wide practical experience in power plant work and industrial electrical equipment. Desires connection. Available immediately. B-2492.

ELECTRICAL-MECHANICAL ENGINEER employed by one of the leading consulting engineers for 13 years is now available. Experience covers design, construction and operation of high pressure steam turbine driven electric generating stations and necessary high tension substations and transmission lines, and all phases of industrial engineering. C-8249.

ASSISTANT TO EXECUTIVE, electrical engineer, university graduate, 2 years' graduate work, 2 years' electrical instrument manufacturing and three years' public utility general testing experience. German fluent, reading knowledge of French, literary ability; engineering reports and correspondence. Pleasing personality, alert, industrious, reliable; excellent references. Wishes to relieve a busy executive. C-930.

ELECTRICAL ENGINEER, 1930 graduate, 25, single. Two years' drafting experience. Desires engineering work with opportunity for advancement. Location, immaterial. C-8437.

EXECUTIVE, production engineer, cost expert, cost accounts, budget control, practical, technical, commercial instruments, telephones, printing, machinery, pressed steel wave enamel, stainless steel, tunnel and galvanized. C-3241.

GRADUATE ELECTRICAL ENGINEER, 30. Two years' railroad shop and power plant experience, 4¾ years large eastern railroad electrical engineer's office drafting and design, appraisal electrical and power plant machinery, investigation and reports of engineering projects. Nineteen months electrician U. S. Shipping Board Diesel and Diesel-Electric motorships. Speak Spanish. C-8160.

ELECTRICAL ENGINEER, college graduate, A. I. T. Good character, married, 24. Pre-college experience: two years' middle-western utilities as electrician's assistant; one year electrical repairs for self. Earned way through college and continuing now in repair business. Would like construction or central station installation work. Location anywhere. Available after June 15. C-8668.

ELECTRICAL ENGINEER, over 20 years' experience, design, construction and operation, power plants, distribution, substation and industrial installations of all kinds. Capable of taking charge either inside or outside or both and showing results. B-7034.

GRADUATE ELECTRICAL ENGINEER, with sound technical training who speaks Spanish readily and has wide technical experience including hydro-electric plant operation, distribution work and some steam experience. Desires responsible position with Latin American utility. B-4132.

ELECTRICAL ENGINEER, B. S., 1929, Westinghouse Student Course 1929-1930, with experience in meter engineering, desires place with public utility company in transmission, distribution or metering, or in development or research work. Will go anywhere. Would also consider engineering instruction job in technical school or college. C-8616.

GRADUATE ELECTRICAL ENGINEER, age 31, married. Eight years' experience including two years G. E. test, 1 year sales, 1 year valuation of lighting and telephone equipment and five years on electrical construction including estimating, layout work, and supervising installations. Desires a permanent connection with a future. B-9090.

ELECTRICAL ENGINEER, 35, technical education with 10 years' executive experience supervising both design and construction. Desires position as engineer in charge of design, or construction or as plant engineer. Location immaterial. C-8683.

SALES AND EXECUTIVE ENGINEER, electrically trained with experience in sales engineering, promotion and management. Would like to take an important part in progressive and high-grade organization. C-5431.

Membership

Transfers Recommended

The board of examiners, at its meetings of December 23, 1930, and January 20, 1931, recommended the following members for transfer to the grades of membership indicated. Any objection to these transfers should be filed at once with the National Secretary.

To Grade of Fellow

BROOKS, HERBERT B., Physicist, Chief of Electrical Instrument Section, Bureau of Standards, Washington, D. C.

HARDING, ARTHUR L., Asst. Elec. Engr., Electric Bond & Share Co., New York.

KELMAN, J. N., President and Manager, Kelman Elec. & Mfg. Co., Los Angeles, Calif.

MOORE, ERNEST E., Consulting Foreign Engineer, Electric Bond & Share Co., New York, N. Y.

STONE, EDMUND C., System Development Mgr., Duquesne Light Co., Pittsburgh, Pa.

To Grade of Member

ALDERMAN, HAYWOOD L., Assistant Engineer, Electric Bond & Share Co., New York.

BABCOCK, ROBERT O., Asst. Engr., Brooklyn Edison Co., Brooklyn, N. Y.

BAILEY, ROBERT C., System Relay Engr., Virginia Elec. & Pr. Co., Richmond, Va.

BENNISON, LIONEL C., Hobart District Engr., Hydro Electric Commission, Hobart, Tasmania.

BRACKETT, HAROLD H., Engr. of Toll Plant Extension and Transmission, N. J. Bell Telephone Co., Newark, N. J.

BRESSLER, JOHN W., Electrical Engineer, Voorhees, Gmelin & Walker, New York

BROCKMEYER, EDGAR W., Vice-President and Secretary, The Brown Brockmeyer Co. Inc., Dayton, Ohio.

BRUNDIGE, JOHN A., Sponsor Engineer, Electric Bond & Share Co., New York.

CHESNUT, FRANK T., Elec. Engr., Ajax Electrothermic Corp., Trenton, N. J.

COOLEY, GILBERT, Asst. Engr., Electric Bond & Share Co., New York.

COONEY, RICHARD T., Supt. of Elec. Const., United Engineers & Constructors, Inc., Philadelphia, Pa.

CREASER, ISAIAH, Elec. Engr., The Replitura Corp., Stamford, Conn.

DAVIDSON, ROSS W., Sponsor Engineer, Electric Bond & Share Co., New York.

FAULKNER, ARTHUR S., Mains Engr., Electricity Dept., Brisbane City Council, Queensland, Australia.

FERGUSON, RANDON, Asst. Engr., Investigation of Stresses in Track, University of Illinois, Urbana, Ill.

FINN, JAMES J., Supt., The Roland T. Oakes Co., Holyoke, Mass.

FRIEND, OTTO A., Telephone Engr., American Tel. & Tel. Co., New York.

FROEHLICH, FREDERICK H., President, The Froehlich & Emery Engg. Co., Toledo, Ohio.

GARDNER, MURRAY F., Asst. Prof. of Elec. Engg., Mass. Inst. of Technology, Cambridge, Mass.

GOULD, LAWRENCE E., President, Economy Elec. Devices Co., Chicago, Ill.

HOISINGTON, N. P., Vice-President, W. V. Pangborne & Co., Inc., Philadelphia, Pa.

HOLDEN, EDWARD A., Asst. Engr., Electric Bond & Share Co., New York.

JICKLING, ROBERT W., Transmission and Distribution Engr., Saskatchewan Power Commission, Regina, Sask., Canada.

KATES, WILLARD A., Development Engr., Corning Glass Works, Corning, N. Y.

KEMP, PHILIP, Head of School of Engg., The Polytechnic, London, England.

LANGDON, GLEN G., Engg. Dept., American Gas & Electric Co., New York.

MACMURCHY, HERBERT G., Asst. Engr., Electric Bond & Share Co., New York.

MANGELS, WALTER C., System Operator, Public Service Elec. & Gas. Co., Newark, N. J.

MOORE, CHARLES R., Member, Technical Staff, Bell Telephone Laboratories, Inc., New York.

MOTTER, HARRY W., Sales and Consulting Elec. Engr., York, Pa.

NEUBER, MAX, Experimental and Development Engr., Moto Meter Gauge & Equipment Co., Toledo, Ohio.

NOTT, GORDON E., Transmission and Protection Engr., Southern California Telephone Co., Los Angeles, Calif.

OSBORN, CHARLES F., Elec. Engr., Ralston Purina Co., St. Louis, Mo.

PAOLINO, SERAFINO, Electrical Designing Draftsman, Pacific Gas & Elec. Co., San Francisco, Calif.

PENMAN, ROY F., Asst. Engr., Electric Bond & Share Co., New York.

PERRIN, LOUIS M., Asst. Elec. Engr., Bureau of Engg., City of San Francisco, San Francisco, Calif.

RICHARDSON, RICHARD P., Asst. Protection Engr., Electricity Dept., Sydney, N. S. W. Australia.

SATTERTHWAITE, J. P., Transmission Maintenance Methods Supervisor, American Tel. & Tel. Co., New York.

SEELEY, ARTHUR P., Elec. Engr., Westcott & Mapes, Inc., New Haven, Conn.

SHAW, ALFRED E., Elec. Engg., Virginia Elec. & Power Co., Richmond, Va.

SILLS, HUBERT R., Asst. Engr., Canadian General Electric Co., Peterboro, Ont., Canada.

SMITH, JOHN A., Elec. Engr., Arthur D. Riley & Co., Ltd., Wellington, N. Z.

STYFF, EIVIND, Elec. Engr., Aktieselskapet Norsk Elektrisk & Brown Boveri, Oslo, Norway.

VAUGHAN, GEORGE W., Asst. Engr., Electric Bond & Share Co., New York.

WHITAKER, WILLIAM G. H., Chief Engr., N. J. Bell Telephone Co., Newark, N. J.

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Applications for Election

Applications have been received by the Secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the Secretary before February 28, 1931.

Abas, J. A., Michigan College of Mining & Technology, Houghton, Mich.

Anderson, G. A., H. B. Squires Co., San Francisco, Calif.

Arapakis, G. H., (Member), New York Edison Co., New York, N. Y.

Arce, M. S., National Railways of Mexico, Chihuahua, Chih., Mexico

Arzadon, F. S., 27 West Superior St., Chicago, Ill.

Ashmead, H. E., American Tel. & Tel. Co., Cleveland, Ohio

Avary, S. A., General Electric Co., Schenectady, N. Y.

Avey, A. F., Niagara & Eastern Power Corp., Buffalo, N. Y.

Babb, M. A., General Electric Co., West Lynn, Mass.

Badgley, W. G., Jr., Public Service Elec. & Gas Co., Irvington, N. J.

Bagg, R. F., New York State, Watertown, N. Y.

Baker, A. E., Pennsylvania Railroad, New York, N. Y.

Baldwin, D. R., Aluminum Co. of America, Alcoa, Tenn.

Baltzar, J., Southern California Edison Co., Big Creek, Calif.

Barzilaski, P. M., N. Y. Navy Yard, Brooklyn, N. Y.

Bates, A. C., Purdue University, West Lafayette, Ind.

Beardsley, K. D., General Electric Co., Pittsfield, Mass.

Behm, J. H., General Electric Co., Schenectady, N. Y.

Bennett, G. R., Jr., 1559 Monterey Place, Mobile, Ala.

Berry, W. S., Underwriters' Laboratories, New York, N. Y.

Braum, C. M., City of Minneapolis, Minneapolis, Minn.

Brown, E. I., Cia. Hidroelectrica Guanajuantense, S. A., Mexico, D. F., Mex.

Bryant, F. R., Kent Owens Machine Co., Toledo, Ohio

Buehler, W. G., American Tel. & Tel. Co., Minneapolis, Minn.

Buel, K. F., Union Electric Light & Power Co., St. Louis, Mo.

Bukey, N. J., Union Gas & Electric Co., Cincinnati, Ohio

Bush, G. L., Teleregister Corp., New York, N. Y.

Cahoon, W. J., Houghton County Elec. Light Co., Houghton, Mich.

Caldwell, J., 3189 Grand Concourse, New York, N. Y.

Cameron, D. A., Public Service Co. of No. Illinois, Chicago, Ill.

Cameron, D. L., Skelly Oil Co., El Dorado, Kans.

Caparone, M. J., Rund Mfg. Co., Pittsburgh, Pa.

Carruth, H. B., Cupp Construction Co., Nashville, Ark.

Carter, B. H., Columbia Gas & Electric Co., Cincinnati, Ohio

Casper, C. L., American Tel. & Tel. Co., Nashville, Tenn.

Cedick, S. J., Cleveland Railway Co., Cleveland, Ohio

Clarendon, C. H., Jr., Weston Electrical Instrument Corp., Newark, N. J.

Clark, G. J., General Electric Co., Toledo, Ohio

Clark, M. C., Pennsylvania Railroad, Long Island City, N. Y.

Clark, W. R., Leeds & Northrup, Philadelphia, Pa.

Clarkson, W. G., Canadian Westinghouse Co,. Hamilton, Ont., Can.

Coan, M., A. S. Riggs, New York, N. Y.

Colson, H. L., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
(Applicant for re-election)

Coyle, W. A., Jr., 573 Hopkins St., Buffalo, N. Y.

Critchett, C. A., Ohio Bell Tel. Co., Dayton, Ohio

Crittendon, L. R., DuPont Ammonia Corp., Belle, W. Va.

Crosno, C. D., Iowa State College, Ames, Ia.

Cummings, H. B., Jr., Georgia Power Co., Atlanta, Ga.

Dapson, F. L., New York & Queens Elec. Lt. & Pr. Co., Flushing, N. Y.

Davis, K. C., General Electric Co., Toledo, Ohio

Demeros, A. G., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Dixon, I. H., Consolidated Gas Elec. Lt. & Pr. Co., Baltimore, Md.

Dorr, G., Toledo Edison Co., Toledo, Ohio

Doss, L. F., New Jersey Bell Tel. Co., Newark, N. J.

Duncan, D. C., Illinois Bell Telephone Co., Chicago, Ill.

Eastman, C. A., Pennsylvania Power & Light Co., Allentown, Pa.

Eckert, O. E., (Member), Board of Water & Electric Light Commissioners, Lansing, Mich.

Elg, G. W., New York Edison Co., New York, N. Y.

Estler, K. E., Westinghouse Lighting Institute, New York, N. Y.

Evans, O. D., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Ewart, J. N., Buffalo General Electric Co., Buffalo, N. Y.

Falconer, M. C., City of Tacoma, Hoodsport, Wash

Farrelly, J. W., Southwestern Bell Tel. Co., San Antonio, Tex.

Ferrick, J. H., American Tel. & Tel. Co., Pittsburgh, Pa.

Fishburne, C. L., Jr., University of South Carolina. Columbia, S. C.

Fisher, C. E., Bell Tel. Labs., New York, N. Y.

Flarida, H. R., Robbins & Myers, Springfield, Ohio

Flippin, A. W., Pacific Gas & Electric Co., Oakland, Calif.

Foley, J. A., General Electric Co., Toledo, Ohio

Forfa, J. S., United Elec. Service Co., New York, N. Y.

Foster, H. K., Dalton-Marsh Co., Danvers, Mass.

Franks, S. T., Canadian & General Finance Co., Ltd., Toronto, Ont., Can.

Freeland, F., Northwestern Electric Co., Portland, Ore.

Fuller, H. M., Philips Wire Co., Darlington, R. I.

Garrett, R. F., Western Electric Co., Kearny, N. J.

Geer, G. D., Texas Electric Service Co., Sweetwater, Tex.

Giddens, A. J., Cleveland Railway Co., Cleveland, Ohio

Gille, W. H., Minneaplis Honeywell Reg. Co., Minneapolis, Minn.

Gillis, J. D., University of Santa Clara, Santa Clara, Calif.

Glendinning, W., Brooklyn Edison Co., Brooklyn, N. Y.

Greenman, H. F., New England Public Service Co., Augusta, Me.

Greer, D. M., Westinghouse Elec. & Mfg. Co., Newark, N. J.

Guenthner, R. H., Northwestern Public Service Co., Yankton, S. D.

Gwathmey, L., General Electric Co., Schenectady, N. Y.

Hague, C. W., General Electric Co., Cleveland, Ohio

Haldeman, W. F., Motor Products Corp., Detroit, Mich.

Hallar, E., United Electric Light Co., Springfield, Mass.

Hamilton, J. A., Bell Tel. Co. of Pa., Pittsburgh, Pa.

Hammer, K. E., Bell Telephone Laboratories, New York, N. Y.

Hansen, P. B., (Member), Graybar Electric Co., Inc., Minneapolis, Minn.

Harrington, J. R., (Member), Howe Signal Co.; Howe Mfg. Co., Chicago, Ill.

Hartig, O., Eagle Electric Mfg. Co., Brooklyn, N. Y.

Haspel, G. K., (Member), Independent Sales & Engineering Co. Ltd., Vancouver, B. C., Can.

Hazelton, R. M., 470 E. 161st St., New York, N. Y.

Heine, T. C., New York Tel. Co., New York, N. Y.

Hellwarth, A. R., University of Michigan, Ann Arbor, Mich.

Helwig, W. F., (Member), Texas Technological College, Lubbock, Tex.

Hendricks, W., Allis-Chalmers Mfg. Co., Pittsburgh, Pa.
Henrikson, F. W., General Electric Co., New York, N. Y.
Hentzen, H. K., Southwestern Bell Tel. Co., Kansas City, Mo.
Hindman, B. W., Public Service Co. of No. Ill., Maywood, Ill.
Hollingshead, E. C., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Horsfall, J. D., Ohio Bell Tel. Co., Cleveland, Ohio
Horvath, J. J., Electric Bond & Share Co., New York, N. Y.
Hoshiai, M., c/o Consulate General of Japan, New York, N. Y.
Hrubec, T. T., General Cable Corp., Perth Amboy, N. J.
Hultberg, C. A., Transformer Corp. of America, Chicago, Ill.
Huskin, F. P., Carolina Power & Light Co., Asheville, N. C.
Hynes, F. B., (Fellow), Crocker Wheeler Elec. Mfg. Co., Ampere, N. J.
Irvine, G. L., General Electric Co., Schenectady, N. Y.
Ivanoff, N. A., D. L. & W. Railroad Co., Hoboken, N. J.
Jacob, F. N., RCA Victor Co., Inc., Mt. Lebanon, Pa.
Janone, V., General Cable Corp., Rome, N. Y.
Jasper, H. N., Jr., American Tel. & Tel. Co., Cleveland, Ohio
Jenkins, S. P., Utah Copper Co., Bingham Canyon, Utah
Jeremiah, W. S., Pennsylvania Power & Light Co., Hazleton, Pa.
Jivatode, R. S., Carolina Pr. & Lt. Co., Raleigh, No. Car.
Jones, H. H., Brooklyn Edison Co., Brooklyn, N. Y.
Jones, T. B., Ohio Brass Co., Dallas, Tex.
Joy, C. H., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Judd, R. S., Southern New England Tel. Co., New Haven, Conn.
Judkins, A., 37 Rolfe St., Auburn, R. I.
Keachie, J. H., General Electric Co., Schenectady, N. Y.
Kemper, G. W., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Kennard, W., 210 Pierce Hall, Cambridge, Mass.
Kerigan, F. A., Pennsylvania Railroad Co., Altoona, Pa.
Kerley, V. E., Oregon State College, Corvallis, Ore.
Killingsworth, H. M., General Electric Co., Philadelphia, Pa.
Kimball, G. S., Stanford University, Stanford University, Calif.
King, W. L., Northwestern Bell Tel. Co., Rapid City, So. Dak.
Kinney, A. B., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Kissner, E., Little & Branch, New York, N. Y.
Klein, H., 687 Lexington Ave., New York, N. Y.
Knapp, E. W., Shawinigan Water & Power Co., Montreal, Que., Can.
Knapp, N., Jr., Bell Tel. Labs., Inc., New York, N. Y.
Knerr, L. R., Pacific Gas & Electric Co., Oakland, Calif.
Kohli, W. W., Standard Sanitary Mfg. Co., Tiffin, Ohio
Korba, A. A., Northern States Power Co., St. Paul, Minn.
Kramer, A., Puget Sound Pr. & Lt. Co., Seattle, Wash.
Lafranchi, V., City Light Dept. of Seattle, Seattle, Wash.
Langford, J. W., Jr., General Electric Co., Philadelphia, Pa.
Larson, H. O., Western Electric Co., Kearny, N. J.
Leary, J. F., Trinidad Leaseholds, Ltd., Trinidad, B. W. I.
Leary, J. R., Bell Tel. Co. of Pa., Pittsburgh, Pa.
Ledermann, W., Sargent & Lundy, Chicago, Ill.
Leithead, R. C., Mass. Inst. of Technology, Cambridge, Mass.
Lewis, F. A., "Electrical Engineering," 33 W. 39th St., New York, N. Y.
Lindell, C. H., Union Gas & Electric Co., Cincinnati, Ohio
Linn, G. J., Commonwealth Edison Co., Chicago, Ill.
Linton, E. W., New York Tel. Co., Brooklyn, N. Y.
Louttit, W. C., (Member). United Railways of Havana, Havana, Cuba
Lucas, E. L., 3959-15th Ave., N. E., Seattle, Wash.
Lucas, F. L., City of Toledo, Toledo, Ohio
Ludlam, G., Western Electric Co., Pittsburgh, Pa.
Mabson, E. B., Louisiana Power & Light Co., Algiers, La.
Mahan, K. C., General Electric Co., Schenectady, N. Y.
Marine, E. H., Bureau of Power & Light of Los Angeles, Saugus, Calif.
Martin, H. L., Westinghouse Elec. & Mfg. Co., Chicago, Ill.
Marx, W. F., Allis-Chalmers Mfg. Co., Pittsburgh, Pa.
Mathewson, H. G., Southwestern Bell Tel. Co., Dallas, Tex.
Matson, J. W., Jr., Union Switch & Signal Co., Swissvale, Pa.
Matthes, L. H., General Electric Co., Beaumont, Tex.
Mattos, G. E., 563 North Sixteenth St., San Jose, Calif.
McCown, R. L., Texas Electric Service Co., Fort Worth, Tex.
McCurley, J. B., Chesapeake & Potomac Tel. Co. of Balto., Baltimore, Md.
McFadden, J. J., Pennsylvania Power & Light Co., Hazleton, Pa.
McHugh, J. H., City of St. Paul, St. Paul, Minn.
McVeety, S. R., Can. General Electric Co., Toronto, Ont., Can.
Metzger, A. F., General Electric Co., Schenectady, N. Y.
Mexal, J. R., Sarvas Electric Co., Inc., New York, N. Y.
Mickle, H. I., Ford Instrument Co., Long Island City, N. Y.
Miller, M. R., 1018 Promontory Ave., Oregon City, Ore.
Molloy, J. A., Brooklyn Edison Co., Brooklyn, N. Y.
Monnier, C. F., New York Power & Light Corp., Albany, N. Y.
Mooshian, J. L., United Electric Lt. & Pr. Co., New York, N. Y.
Morris, H. D., Stone & Webster Engg. Corp., Boston, Mass.
Morrison, C., Potomac Edison Co., Hagerstown, Md.
Morse, M. F., New York Tel. Co., Brooklyn, N. Y.
Mucher, G. J., Clarostat Mfg. Co., Inc., Brooklyn, N. Y.
Newhouse, S. E., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Nicholson, G. J., New York & Queens Elec. Lt. Co., Flushing, N. Y.
Oberbauer, C. T., Edgar, Mont.
O'Callaghan, J. J., Stewart Wagner Corp., Chicago, Ill.
Odbert, E. W., Jr., Sturgeon Bay Co., Sturgeon Bay, Wis.
Oehlwein, O. L., Public Service Co. of No. Ill., Evanston, Ill.
Oliver, R. A., New York Central Railroad, New York, N. Y.
Olsen, O. F., General Electric Co., Schenectady, N. Y.
Oppenheimer, M. L., North American Electric Lamp Co., St. Louis, Mo.
Orrick, E. F., General Electric Co., Schenectady, N. Y.
Osborne, R. H., Public Service Co. of No. Illinois, Joliet, Ill.
Osgood, R. H., Hazard Insulated Wire Works, New York, N. Y.
Ott, W. M., New York Tel. Co., Syracuse, N. Y.
Pabalan, R. L., Brooklyn Edison Co., Inc., Brooklyn, N. Y.
Paulaharju, L. J., Can. Westinghouse Co. Ltd., Hamilton, Ont., Can.
Paulding, H. L., Dow Jones & Co., New York, N. Y.
Peach, P. S., 315 N. Highland Ave., Pittsburgh, Pa.
Pennock, E. C., Westinghouse Elec. & Mfg. Co., Denver, Colo.
Peugnet, C. R., Rensselaer Polytechnic Institute, Troy, N. Y.
Pfester. P., Cleveland Railway Co., Cleveland, Ohio
Plant, I. M., Brooklyn Edison Co., Brooklyn, N. Y.
Poohan, S. L., R. C. A. Photophone, Inc., New York, N. Y.
Poole, G. D., Western Union Telegraph Co., Chicago, Ill.
Potter, D. F., Jr., (Member), Kuhlman Electric Co., New York, N. Y.
Pritham, C. F., N. Y. N. H. & H. R. R. Co., New Haven, Conn.
Pyne, A. N., Union Carbide Co. & Electro Metallurgical Co., Niagara Falls, N. Y.
Quell, C. H., General Talking Pictures Corp., New York, N. Y.
Quirk, M. J., Ford Motor Co., Dearborn, Mich.
Rehm, W. P., U. S. Lines, Inc., New York, N. Y.
Remon, J. A., (Member), Chesapeake & Potomac Tel. Co., Richmond, Va.
Reynolds, R. I., Syracuse Lighting Co., Inc., Syracuse, N. Y.
Ring, D. H., Bell Telephone Laboratories, Red Bank, N. J.
Rollman, W. H., Memphis Power & Light Co., Memphis, Tenn.
Rothstein, A. I., Kansas City Pr. & Lt. Co., Kansas City, Mo.
Rowe, H. N., General Electric Co., Schenectady, N. Y.
Roy, J. A., Bureau of Ordnance, Navy Dept., Washington, D. C.
Roy, K. C., Mass. Inst. of Technology, Cambridge, Mass.
Rudder, A. L., Hydro Electric Power Comm. of Ontario, Toronto, Ont., Can.
Rudiger, C. E., Cornell University, Ithaca, N. Y.
Rys, F. E., Westinghouse Elec. & Mfg. Co., Bondsville, Mass.
Sanderson, B. E., Public Service Co. of No. Illinois, Chicago, Ill.
Sandstrom, A. T., Anaconda Copper Mining Co., Butte, Mont.
Sandstrom, F. G., New York & Queens Elec. Lt. & Pr. Co., Flushing, N. Y.
Schaub, W. R., Bureau of Standards, Washington, D. C.
Schlesinger, O. J., (Member), A. A. Electric Co., Cicero, Ill.
Schlottmann, F. W., Brooklyn Edison Co., Inc., Brooklyn, N. Y.
Schmidt, E. C., Southwestern Bell Tel. Co., St. Louis, Mo.
Schmitt, W. H., Brooklyn Edison Co., Inc., Brooklyn, N. Y.
Schoemann, A. F., General Electric Co., Philadelphia, Pa.
Schultz, C. H., John C. Morris, Inc., Jersey City, N. J.
Schwab, D., Engert-Hellman, Inc., New York, N. Y.
Schwarzkopf, E., 3733-80th St., Jackson Heights, L. I., N. Y.
Sharp, W. B., Southern Bell Tel. Co., Jackson, Miss.
Shoemaker, L. E., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Schoenfeld, K., E. A. Everett, Long Island City, N. Y.

Siekman, P. W., Pennsylvania Power & Light Co., Hazleton, Pa.
Sigman, H. F., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Sissung, E. P., M. H. Schmoyer, Allentown, Pa.
Skinner, C. R., Correct Recording System Mfg. Co., Palo Alto, Calif.
Smeed, R. W., 1740 East 116th Place, Cleveland, Ohio
Smith, G. A., Bell Tel. Laboratories, New York, N. Y.
Snyder, E. R., Sargent & Lundy, Chicago, Ill.
Stanfield, D. R., So. Calif. Tel. Co., Los Angeles, Calif.
Stelpstra, E. J., Western Electric Co., Inc., Newark, N. J.
Strasbourger, J. C., Cleveland Electric Illuminating Co., Cleveland, Ohio
Strazzella, A. F., Bethlehem Steel Co., Milroy, Pa.
Stringham, R. P., University of Kansas, Lawrence, Kans.
Strohl, W. M., Bell Tel. Labs., Red Bank, N. J.
Strong, C. H., National Inspection Co., Chicago, Ill.
Stuttle, A. F., Ohio Bell Tel. Co., Toledo, Ohio
Swingle, A. W., General Electric Co., Schenectady, N. Y.
Tarvin, E. R., American Tel. & Tel. Co., New York, N. Y.
Taylor, C. F., Western Electric Co., Seattle, Wash.
Thomas, J. E., Brooklyn Edison Co., Brooklyn, N. Y.
Thomas, M. I., 8747 Laflin St., Chicago, Ill.
Thomas, R. E., (Member), Bell Tel. Co. of Pa., Wilkes-Barre, Pa.
Thomson, W. A., Northern Electric Co., Montreal, Que., Can.
Tietzow, O. E., Sargent & Lundy, Inc., Chicago, Ill.
Toepfer, A. H., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Turner, W. O., Louisiana Power & Light Co., Algiers, La.
Turpin, A. F., Public Service Co. of No. Ill., Waukegan, Ill.
Tycks, C. P., Staten Island Edison Corp., Livingston, S. I., N. Y.
Ullman, R., Brown Instrument Co., Philadelphia, Pa.
Vatcher, G. I., Urquehart-Hardy Radio Labs., Dorchester, Mass.
Vest, W. L., Jr., Western Massachusetts Companies, Springfield, Mass.
Victors, P., Shell Chemical Co., Pittsburg, Calif.
Volkmann, H., 3523 North 18th St., Milwaukee, Wis.
Walker, C. M., Champion Radio Works, Inc., Danvers, Mass.
Walsh, T. N., Geophysical Service, Inc., Dallas, Tex.
Walters, H. B., Allis-Chalmers Mfg. Co., Pittsburgh, Pa.
Webber, T. T., New York Fire Dept., Woodhaven, N. Y.
Weber, E., Brooklyn Polytechnic Institute, Brooklyn, N. Y.
Weber, F. D., Western Electric Co., Chicago, Ill.
Weil, R. G., Bell Tel. Labs., New York, N. Y.
Welch, H., Westinghouse Elec. & Mfg. Co., Springfield, Mass.
Wendegatz, L. G., Line Material Co., Kansas City, Mo.
West, W. B., (Member), 22 East 38th St., New York, N. Y.
Williams, G. M., Public Service Co. of No. Ill., Crystal Lake, Ill.
Wirth, S., Brooklyn Edison Co., Brooklyn, N. Y.
Witt, M., Georgia Power Co., Atlanta, Ga.
Woodward, H., Annapolis & Chesapeake Power Co., Annapolis, Md.
Wylie, D. N., Allis-Chalmers Mfg. Co., Pittsburgh, Pa.
Total 281

Foreign

de la Serna, R. T., Cia. Interprovincial de Servicios Publicos Buenos Aires, Argentina, So America
Del Ray, J., Electric Supply Co., Cuttack, India
Hayath, M., Government of Mysore, Bangalore, India
Iyengar, K. I., Government of India, Bombay, India
Knight, S. A., Irak Petroleum Co., Ltd., Tuz Khurmatu, Irak
Pratt, A. A., Riegos y Fuerza del Ebro, S. A., Provincia de Lenida, Spain
Smith, J. A., Australian General Electric Co., Ltd., Adelaide, South Australia
Snyder, I. W., Standard Oil Co., Yokohama, Japan
Sugaya, Y., Nagoya Communications, Higashi-Ku, Nagoya-Shi, Japan
Utley, C. L., Empresas Electricas, Rio de Janeiro, Brazil, So. America
Watts, E. A., Municipal Council of Sydney, New South Wales, Australia
White, C. E., (Member), Century Electric Co. of St. Louis, Mo., London, Eng.
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(A list of the personnel of Institute committees may be found in the January issue of ELECTRICAL ENGINEERING)

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Publication	W. S. Gorsuch
Coordination of Institute Activities	H. P. Charlesworth
Board of Examiners	H. W. Drake
Sections	Everett S. Lee
Student Branches	W. H. Timbie
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Headquarters	R. H. Tapscott
Law	E. B. Meyer
Public Policy	Bancroft Gherardi
Standards	F. D. Newbury
Edison Medal	D. C. Jackson
Lamme Medal	Charles F. Scott
Code of Principles of Professional Conduct	F. B. Jewett
Award of Institute Prizes	A. E. Knowlton
Safety Codes	A. W. Berresford
Engineering Profession	H. A. Kidder
Columbia University Scholarships	W. I. Slichter
Popular Science Award	A. E. Knowlton
Advisory Committee to the Museum of Science and Industry in the City of New York	J. P. Jackson

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Communication	G. A. Kositzky
Education	W. R. Work
Electrical Machinery	Philip L. Alger
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Electrophysics	O. E. Buckley
General Power Applications	C. W. Drake
Instruments and Measurements	E. J. Rutan
Applications to Iron and Steel Production	A. C. Cummins

Production and Application of Light	George S. Merrill
Applications to Marine Work	R. A. Beekman
Applications to Mining Work	Carl Lee
Power Generation	F. A. Allner
Power Transmission and Distribution	P. H. Chase
Protective Devices	Raymond Bailey
Research	L. W. Chubb
Transportation	Sidney Withington

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(The Institute is represented on the following bodies; the names of the representatives may be found in the January issue of ELECTRICAL ENGINEERING)

Aeronautical Radio Research, Liaison Committee on

Alfred Noble Prize Committee, A. S. C. E.

American Association for the Advancement of Science, Council

American Bureau of Welding

American Committee on Electrolysis

American Engineering Council Assembly

American Marine Standards Committee

American Standards Association

American Year Book, Advisory Board

Charles A. Coffin Fellowship and Research Fund Committee

Committee of Apparatus Makers and Users, National Research Council

Committee on Elimination of Fatigue, Society of Industrial Engineers

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Joint Committee on Welded Rail Joints

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No. 2—Middle Eastern	E. C. Stone, Duquesne Light Co., 435 Sixth Ave., Pittsburgh	J. A. Cadwallader, Bell Tel. Co. of Pa., 416 Seventh Ave, Pittsburgh
No. 3—New York City	H. P. Charlesworth, 463 West St., New York	C. R. Jones, Westinghouse E. & M. Co., 150 Broadway, New York
No. 4—Southern	W. S. Rodman, Box 675, University, Va.	J. S. Miller, Jr., Box 12, University, Va.
No. 5—Great Lakes	T. N. Lacy, Mich. Bell Tel. Co., 1365 Cass Ave., Detroit	A. G. Dewars, No. States Pr. Co., 15 S. 15th St., Minneapolis
No. 6—North Central	Herbert S. Evans, University of Colorado, Boulder, Colo.	M. S. Coover, University of Colorado, Boulder, Colo.
No. 7—South West	G. C. Shaad, University of Kansas, Lawrence, Kans.	Robert W. Warner, University of Kansas, Lawrence, Kans.
No. 8—Pacific	C. E. Fleager, Pac. Tel. & Tel. Co., 140 New Montgomery St., San Francisco	H. W. Hitchcock, 1050 Telephone Bldg., 740 South Olive St., Los Angeles
No. 9—North West	H. V. Carpenter, State College of Washington, Pullman, Wash.	R. D. Sloan, State College of Washington, Pullman, Wash.
No. 10—Canada	C. E. Sisson, Canadian Gen. Elec. Co., 1025 Lansdowne Ave., Toronto, Ont.	W. L. Amos, Hydro-Elec. Pr. Com., 190 University Ave., Toronto, Ont.

Note: Each District Executive Committee includes the chairmen and secretaries of all Sections within the District and the chairman of the District Committee on Student Activities.

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Name	District	Chairman	Secretary	Secretary's Address
Akron	2	H. C. Paiste	Alvin P. Regal	Phila. Rubber Works Co., Akron, Ohio
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Baltimore	2	W. B. Kouwenhoven	J. Wells	Western Elec. Co., 25 Broening Rd., Baltimore, Md.
Birmingham	4		O. E. Charlton	Allied Engineers, Inc., Birmingham, Ala.
Boston	1	J. P. Kobrock	G. J. Crowdes	Simplex Wire & Cable Co., Sidney St., Cambridge, Mass.
Chicago	5	F. H. Lane	L. R. Mapes	Ill. Bell Tel. Co., 212 W. Washington St., Chicago, Ill.
Cincinnati	2	T. C. Reed	L. L. Bosch	Columbia Eng. & Mgt. Corp., 314 West 4th St., Cincinnati, Ohio
Cleveland	2	F. W. Braund	John M. Smith	Nela Park, Cleveland, Ohio
Columbus	2	C. D. Price	K. Y. Tang	Ohio State University, Columbus, Ohio
Connecticut	1	Samuel Ferguson	R. G. Warner	Yale Univ., 10 Hillhouse Ave., New Haven, Conn.
Dallas	7	L. T. Blaisdell	G. A. Dyer	Southwestern Bell Tel. Co., Dallas, Texas
Denver	6	R. B. Bonney	N. R. Love	807 Tramway Bldg., Denver, Colo.
Detroit-Ann Arbor	5	LeRoy Braisted	J. J. Shoemaker	Detroit Edison Co., 2000-2nd Ave., Detroit, Mich.
Erie	2	G. R. McDonald	G. I. LeBaron	General Elec. Co., Erie, Pa.
Fort Wayne	5	W. J. Morrill	C. M. Summers	General Elec. Co., Fort Wayne, Ind.
Houston	7	C. D. Farman	Hezzie Clark	Humble Pipe Line Co., Drawer, 1761, Houston, Texas
Indianapolis-Laf	5	E. G. Ralston	C. E. Dutton	15 W. New York St., Room 222, Indianapolis, Ind.
Iowa	5	J. K. McNeely	H. B. Hoffhaus	Des Moines El. Lt. Co., 312-6th Ave., Des Moines, Iowa
Ithaca	1	W. C. Ballard, Jr.	W. E. Meserve	614 E. Buffalo St., Ithaca, N. Y.

LOCAL SECTIONS OF THE INSTITUTE—*Continued*

Name	District	Chairman	Secretary	Secretary's Address
Kansas City	7	J. S. Palmer	Richard M. Ryan	510 Dwight Bldg., Kansas City, Mo.
Lehigh Valley	2	W. M. Harbaugh	J. H. Diefenderfer	Penn. Pr. & Lt. Co., Hazleton, Pa.
Los Angeles	8	H. W. Hitchcock	Philip S. Biegler	3551 University Ave., Los Angeles, Calif.
Louisville	4	James Clark, Jr	Philip P. Ash	L. & N. R. R. Bldg., 9th and Broadway Ave., Louisville, Ky.
Lynn	1	A. L. Ellis	W. K. Dickinson	General Elec. Co., West Lynn Works, Lynn, Mass.
Madison	5	L. C. Larson	G. F. Tracy	Elec. Lab. Bldg., Univ. of Wisconsin, Madison, Wis.
Memphis	4	M. Eldredge	W. A. Gentry	Memphis Pr. & Lt. Co., Memphis, Tenn.
Mexico	3	B. E. Arias	L. Castro, Jr	Departamento Electricidad y Telegrafos, Ferrocarriles Nacionales de Mexico, Mexico, D. F.
Milwaukee	5	F. A. Kartak	I. L. Illing	Milwaukee El. Ry. & Lt. Co., 380 Pub. Serv. Bldg., Milwaukee, Wis.
Minnesota	5	D. K. Lewis	H. J. Pierce	Northwestern Bell Tel. Co., Minneapolis, Minn.
Nebraska	6	W. O. Jacobi	A. L. Turner	1112 Telephone Bldg., Omaha, Nebraska
New York	3	J. B. Bassett	C. R. Jones	Westinghouse E. & M. Co., 150 Broadway, New York, N. Y.
Niagara Frontier	1	E. S. Bundy	G. W. Eighmy	General Elec. Co., 1100 Elec. Bldg., Buffalo, N. Y.
North Carolina	4	J. H. Paget	F. C. DeWeese	Carolina Pr. & Lt. Co., Raleigh, N. C.
Oklahoma City	7	F. J. Meyer	C. E. Bathe	Oklahoma Gas & Elec. Co., Oklahoma City, Okla.
Philadelphia	2	D. H. Kelly	J. L. MacBurney	El. St. Bat. Co., 1955 Hunting Park Ave., Phila., Pa.
Pittsburgh	2	C. T. Sinclair	F. A. Connor	General Elec. Co., 1309 Oliver Bldg., Pittsburgh, Pa.
Pittsfield	1	C. H. Kline	L. H. Burnham	General Electric Co., Pittsfield, Mass.
Portland, Ore	9	A. H. Kreul	C. W. Fick	General Electric Co., Portland, Oregon
Providence	1	J. W. Young	O. W. Briden	Blackstone Valley G. & E. Co., 231 Main St., Pawtucket, R. I.
Rochester	1	Harvey J. Klumb	F. C. Young	Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
St. Louis	7	C. B. Fall	E. A. Forkner	Wagner Elec. Corp., 6400 Plymouth Ave., St. Louis, Mo.
San Antonio	7	D. W. Flowers	E. Bissett	San Antonio P. S. Co., 201 N. St., Mary St., San Antonio, Texas
San Francisco	8	P. B. Garrett	E. F. Maryatt	Pacific G. & E. Co., 245 Market St., San Francisco, Calif.
Saskatchewan	10	W. T. Hunt	A. B. Coward	Light and Power Dept., Regina, Sask., Canada
Schenectady	1	E. S. Henningsen	E. P. Nelson	D. C. Eng. Dept. General Elec. Co., Schenectady, N. Y.
Seattle	9	C. E. Carey	Philip D. Jennings	5560 Stuart Bldg., Seattle, Wash.
Sharon	2	S. S. Cook	R. M. Field	Westinghouse E. & M. Co., Sharon, Pa.
Southern Virginia	4	J. H. Berry	Cecil Gray	Westinghouse E. & M. Co., 912 El. Bldg., Richmond, Va.
Spokane	9	Loren A. Traub	C. F. Norberg	Washington Water Pr. Co., Spokane, Wash.
Springfield, Mass	1	J. N. Alberti	L. C. Packer	Westinghouse E. & M. Co., Page Blvd., Springfield, Mass.
Syracuse	1	F. E. Verdin	Charles W. Henderson	504 University Pl., Syracuse, N. Y.
Toledo	2	F. H. Dubs	Max Neuber	1257 Fernwood Ave., Toledo, Ohio
Toronto	10	D. A. McKenzie	G. D. Floyd	Hydro El. Pr. Comm., 190 Univ. Ave., Toronto, Ont.
Urbana	5	C. E. Skroder	W. J. Putnam	123 Mat. Test. Lab. Univ. of Illinois, Urbana, Ill.
Utah	9	L. B. Fuller	Paul Ranson	Utah Apex Mining Co., Bingham Canyon, Utah
Vancouver	10	H. Vickers	C. Arnott	B. C. E. Ry. Co., Ltd., 425 Carrall St., Vancouver, B. C.
Washington	2	George W. Vinal	J. L. Carr	General Elec. Co., 800-15th St., N. W., Washington, D. C.
Worcester	1	J. K. Oldham	R. P. Bullen	General Elec. Co., Worcester, Mass.
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Alabama, Univ. of	University, Ala	4	Walter H. Croft	Harold B. Hendrix	F. R. Maxwell, Jr.
Arizona, Univ. of	Tucson, Ariz	8	W. T. Brinton	Carl Ludy	J. C. Clark
Arkansas, Univ. of	Fayetteville, Ark	7	Ned S. Muse	E. Wylie Head	W. B. Stelzner
Armour Inst. of Tech	Chicago, Ill	5	K. A. Knittel	E. Squires	D. E. Richardson
British Columbia, Univ. of	Vancouver, B. C	10	M. A. Thomas	E. M. Kershaw	E. G. Cullwick
Brooklyn, Poly. Inst. of	Brooklyn, N. Y	3	George Morton	F. Anderson	Robin Beach
Bucknell Univ	Lewisburg, Pa	2	O. R. Sterling	P. Hort	W. K. Rhodes
Calif. Inst. of Tech	Pasadena, Calif	8	A. W. Strong	J. E. Girard	R. W. Sorensen
Calif., Univ. of	Berkeley, Calif	8	Harry C. Stanley	Louis Zable	L. E. Reukema
Carnegie Inst. of Tech	Pittsburgh, Pa	2	M. W. Smedberg	G. H. Ikola	G. Porter
Case Sch. of Ap. Science	Cleveland, Ohio	2	G. A. Sanow	Irwin J. Rand	H. B. Dates
Catholic Univ. of America	Washington, D. C	2			T. J. MacKavanagh
Cincinnati, Univ. of	Cincinnati, Ohio	2	F. F. Osterholtz	Henry Suter	W. C. Osterbrock
Clarkson College of Tech	Potsdam, N. Y	1	E. S. Whitaker	C. L. Brown	A. R. Powers
Clemson Agri. College	Clemson College, S. C	4	C. E. Jarrard	G. A. Douglass	S. R. Rhodes
Colorado, State Agri. College	Ft. Collins, Colo	6	Henry Wamboldt	L. Dougherty	F. L. Poole
Colorado, University of	Boulder, Colo	6	R. Partington	John Buffo	W. C. DuVall
Cooper Union	New York, N. Y	3	H. Grissler	A. B. Mundel	A. J. B. Fairburn
Cornell University	Ithaca, N. Y	1	C. O. Dean	Wm. E. Brainard	E. M. Strong
Denver, Univ. of	Denver, Colo	6	Harry H. Ward	Fay Olmsted	R. E. Nyswander
Detroit, Univ. of	Detroit, Michigan	5	W. R. Moyers	L. F. Ross	H. O. Warner
Drexel Inst	Philadelphia, Pa	2	E. K. Cliver	G. R. Bowers	E. O. Lange
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Name	Location	District	Chairman	Secretary	Counselor (Member of Faculty)
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Iowa State College	Ames, Iowa	5	George A. Estel	A. W. Chewning	F. E. Johnson
Iowa, State Univ. of	Iowa City, Iowa	5	J. Westley Campian	D. A. Cozine	E. B. Kurtz
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Kansas, Univ. of	Lawrence, Kansas	7	J. Warner	F. Shiner	D. C. Jackson, Jr.
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Lehigh Univ	Bethlehem, Pa	2	P. W. Seal	L. R. Wanner	N. S. Hibshman
Lewis Inst	Chicago, Ill	5	C. B. Frellsen	K. J. Sinclair	F. A. Rogers
Louisiana State Univ	Baton Rouge, La	4	Fred H. Fenn	R. A. Crain	M. B. Voorhies
Louisville, Univ. of	Louisville, Ky	4	John G. Lips	Wm. E. Bailey	S. T. Fife
Maine, Univ. of	Orono, Maine	1	Monroe E. Moon	Lincoln O. Spencer	W. E. Barrows, Jr.
Marquette Univ	Milwaukee, Wis	5	David Becker	Edward Halback	Edward Kane
Massachusetts Inst. of Tech	Cambridge, Mass	1	G. S. Brown	Fred J. Elser	W. H. Timbie
Michigan Col. of Mining and Tech	Houghton, Mich	5	A. G. Rogers	M. D. Crowell	G. W. Swenson
Michigan State College	East Lansing, Mich	5	Robert Dearing	J. J. Clark	W. A. Murray
Michigan, Univ. of	Ann Arbor, Michigan	5	A. D. Forbes	G. Muffly	B. F. Bailey
Milwaukee, School of Eng. of	Milwaukee, Wis	5	William P. Gainer	H. F. Volkmann	Oscar Werwath
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Mississippi Agri. & Mech. Col	A. &. M. College, Miss	4	J. M. Leigh	J. T. Young	L. L. Patterson
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Nevada, Univ. of	Reno, Nevada	8	Francis Headley	Eugene Tucker	S. G. Palmer
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New Mexico, Univ. of	Albuquerque, New Mexico	7	C. E. Henderson	S. M. Pelatowski	F. M. Denton
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North Carolina, Univ. of	Chapel Hill, N. C	4	G. D. Thompson	Charles Hayes	J. E. Lear
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North Dakota, Univ. of	Grand Forks, N. D	6	C. J. Breitwieser	R. C. McConnell	H. F. Rice
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Ohio State Univ	Columbus, Ohio	2	G. F. Leydorf	R. W. Steenrod	F. C. Caldwell
Ohio Univ	Athens, Ohio	2	H. Swigart	H. Adcock	A. A. Atkinson
Oklahoma Agri. & Mech. Col	Stillwater, Okla	7	Paul H. Foster	Merle C. Brady	A. Naeter
Oklahoma, Univ. of	Norman, Okla	7	G. S. Hammonds	William J. Fell	F. G. Tappan
Oregon State College	Corvallis, Oregon	9	H. Glen Barnett	Gordon N. Smith	F. O. McMillan
Pennsylvania State College	State College, Pa	2	S. E. McKibben	E. L. Johnston	L. A. Doggett
Pennsylvania, Univ. of	Philadelphia, Pa	2	Wm. D. Bruce	C. V. Castle	C. D. Fawcett
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Industrial Notes

South American Agent for Ohio Brass Company.—The Ohio Brass Company, Mansfield, Ohio, announces the appointment of Pirelli S/A, with offices in Rio de Janeiro and Sao Paulo, as Brazilian agent for that company in South America. Pirelli S/A, a branch of the Pirelli Company of Italy, large manufacturers of cables, chemicals, rubber goods, etc. maintains an extensive selling organization throughout Brazil.

General Electric Orders.—Orders received by the General Electric Company during the year 1930 amounted to $341,820,312, compared with $445,802,519 for 1929, a decrease of 23 per cent, President Gerard Swope has announced. Orders for the final quarter of 1930 amounted to $74,168,480, compared with $108,398,049 for the last quarter of 1929, a decrease of 32 per cent. As a result of the transfer of radio set and tube business, outlined in the company's 1929 annual report, orders received in 1930 do not include radio sets and tubes, except orders received for the new General Electric radios introduced in the latter part of the year.

U. S. Leads in Radio Exports.—According to a recent announcement from the Department of Commerce in Washington, more than 24,000,000 radio sets are in use throughout the world today, 45% being in the United States. Socket power sets account for 52% of the total number of sets in use in North America. In the majority of cases, outside of the United States and Canada, the cost of broadcasting is paid by a system of license fees levied on the sets in use, and these fees range from as low as thirty-nine cents in France to as high as $44 per set in Turkey. The average license fee, however, runs between $3 and $4. The United States is the world's largest exporter.

A New High Voltage Testing Set.—A highly accurate testing set of unusually flexible design, the AmerTran Type TS-15A, has been developed by by the American Transformer Company, 180 Emmet Street, Newark, N. J. This apparatus is ideally suited for light testing in either the factory or laboratory where potentials from 500 to 20,000 volts at 1 kv-a. are required. It is applicable in making accurate dielectric strength measurements on materials such as paper, tape, compound, varnished cambric, condensers, and insulation in small apparatus. The new AmerTran testing set operates from standard 110-volt, 60-cycle circuits and contains a special air-cooled testing transformer with a four-section secondary winding which permits of obtaining three different voltages at full output—5,000, 10,000 and 20,000. In addition the equipment includes a wire-wound potentiometer for adjusting the voltage to any value between zero and maximum, the exact value being indicated at all times by a precision double-range voltmeter connected to a special winding on the transformer. For protection against damage due to overload a quick-acting circuit breaker is provided. The unit is completely housed in a compact metal case on the front of which is mounted a Bakelite panel containing all operating controls.

Trade Literature

Linemen's Tools.—Bulletin 30, 68 pp. Describes a complete line of tools, belts, etc., for linemen and other electrical workers. Mathias Klein & Sons, 3200 Belmont Ave., Chicago.

Neon Glow Lamps.—Folders (2). Describe the characteristics and uses of standard neon glow lamps. General Electric Vapor Lamp Company, Hoboken, N. J.

Steam Turbines.—Bulletins GEA 1011B and 1080A, each 12 pages. Describe the design and construction of turbines for isolated plants and central stations. General Electric Company, Schenectady, N. Y.

Electroplating Aluminum.—Booklet, 36 pp., "Electroplating Aluminum." Describes the process of chromium plating and nickelplating of aluminum and alloys. Aluminum Company of America, Oliver Building, Pittsburgh.

Micarta.—Bulletin 1686-A, 16 pp., "Micarta in the Central Station." Describes Micarta insulation for power houses and substations, insulating bus bars and connections, and other applications. Westinghouse Electric & Mfg. Company, East Pittsburgh.

Test-Signal Generator.—Catalog supplement F-200, 4 pp. Describes type 404 test-signal generator for use in comparing performances of radio receivers, or of one receiver under various conditions. This apparatus has been designed with the requirement of service testing in mind. General Radio Company, Cambridge (A), Mass.

Direct-Current Volt-Ohmmeter.—Supplement 3 to Bulletin 100. Describes a new instrument, type PD, direct-current volt-ohmmeter, which may be used for continuity testing, as a direct reading ohmmeter, or for reading voltages up to 600 volts, direct current. It is recommended by the manufacturer particularly for radio testing. Roller-Smith Company, 12 Park Place, New York.

Quadrant Electrometer.—Bulletin 330, 4 pp. Describes the "Compton quadrant electrometer." This instrument, according to the manufacturer, is probably the most delicate electrostatic instrument available, and due to its simplicity and high sensitiveness it has been widely used during the past few years in much of the best research work involving accurate electrostatic measurements. The Rubicon Company, 29 No. 6th Street, Philadelphia.

Rossman Speed Control.—Bulletin 1151, 12 pp. Describes the Rossman system of adjustable speed control which involves a method of controlling the speed of a given alternating-current drive machine over a wide speed range. It is being used with particular success for operating auxiliary equipment in large power plants. Allis-Chalmers Manufacturing Company, Milwaukee.

Lighting Panels,—Bulletin 12 pp. Describes the new "Superba" lighting panel, which is a revolutionary attempt to give attractive form to this equipment and get away from the staid straight lines of the conventional type at the same time. A more important feature is the greater flexibility and scientific design of the board from electrical and mechanical standpoints. Changes of circuit connections for both voltage and phase may be made readily without removing the door and trim or disturbing the wiring connections. These panels are composed of Bakelite units that can be furnished in a variety of colors to match background color schemes. Bull Dog Electric Products Company, 7610 Jos. Campau Avenue, Detroit.

Electric Heating Equipment.—Catalog 247, 100 pp. Describes Westinghouse industrial heating equipment and includes operating data, charts, and tables. The catalog contains definitions of terms relating to heat treatment operations, tables for determining furnace sizes and operating costs, descriptions of different furnaces, a section devoted to installation photographs, and specifications for industrial heating appliances such as air heaters, electric glue pots, electric snow melters for track switches, and oil immersion heaters. The last section of the publication consists of a control section describing magnetic controllers, push button stations, furnace transformers, thermometers, thermostats, pyrometers, etc., making this a comprehensive and complete publication on the subject of industrial heating. Westinghouse Electric & Mfg. Company, East Pittsburgh.

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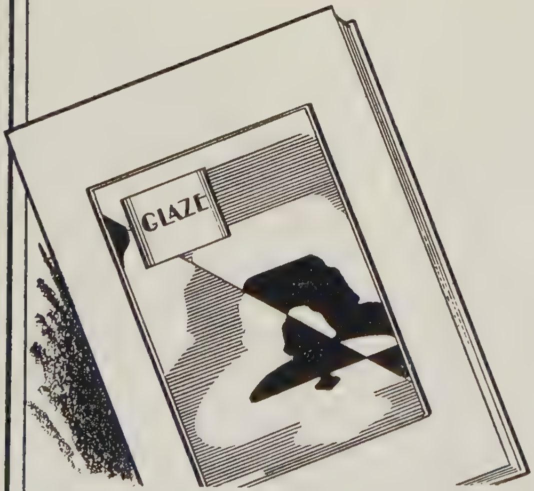

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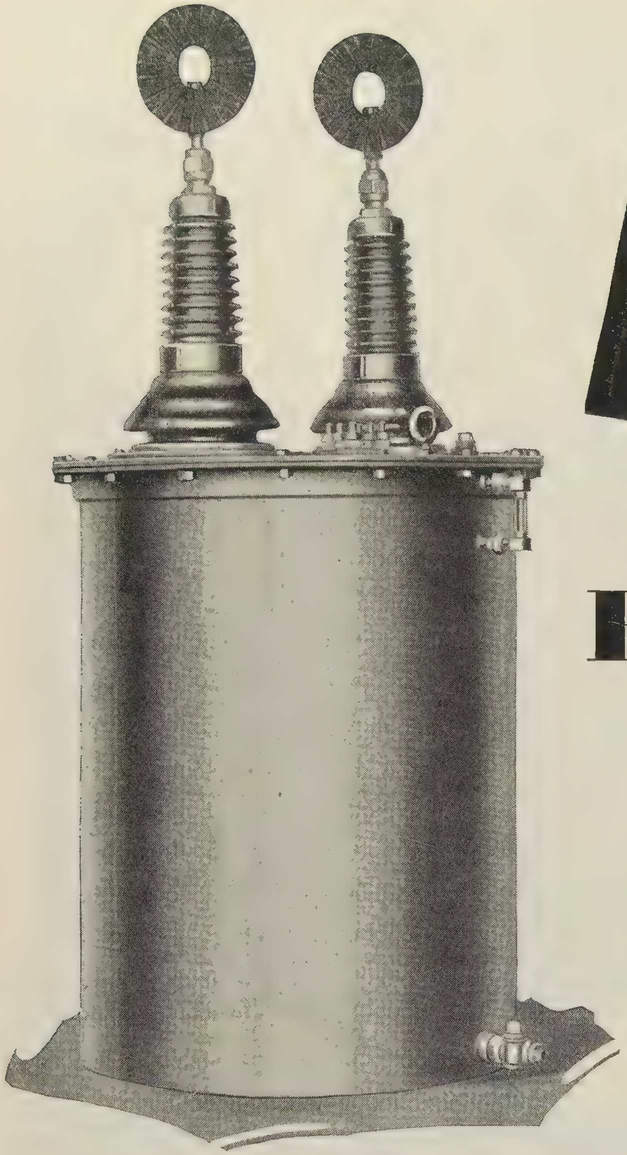

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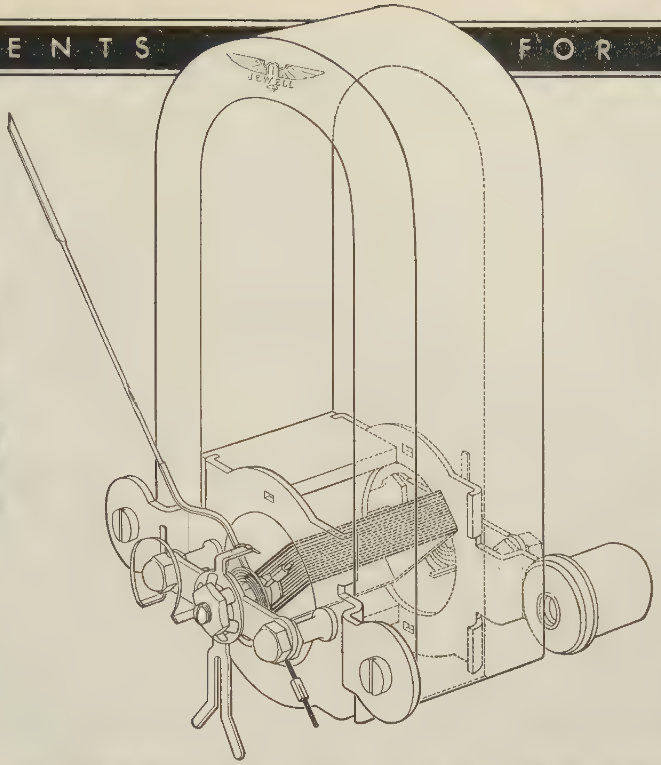

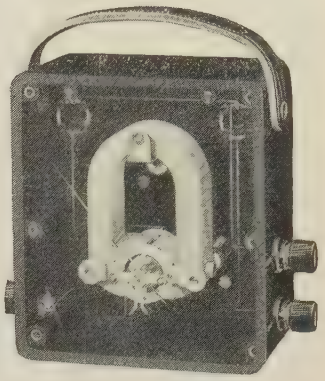

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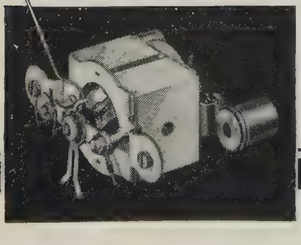

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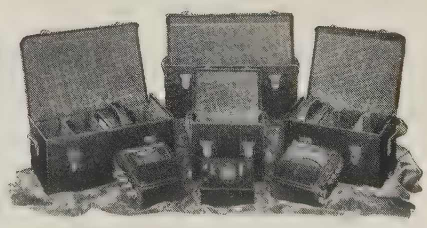

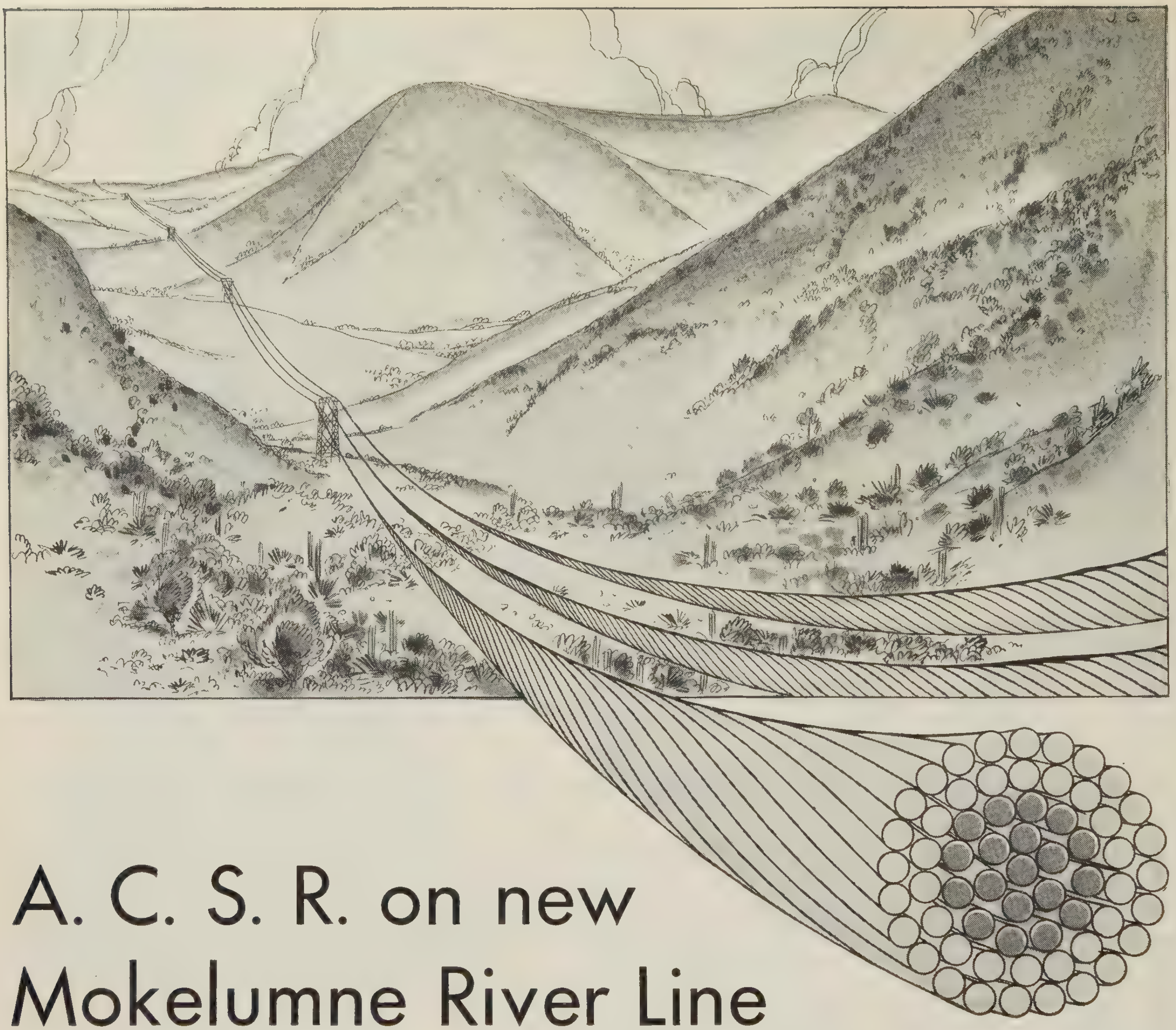

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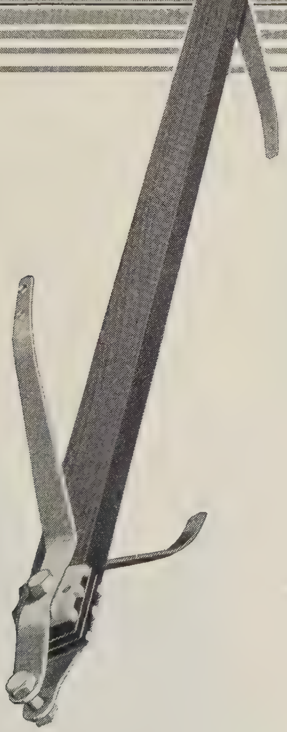

The self-tightening grip, a most important and exclusive feature of O-B Wood Strain Insulators, by the introduction of outer wedge plates and inner friction plates, provides a firm and lasting grip. It secures a uniform distribution of stress, thus developing the maximum strength of the wood, and prevents loosening of the grip in event of the commonly experienced weather shrinkage.

FREQUENTLY the commonly recognized high insulation values of wood poles and structures are largely dissipated by the use of uninsulated or under-insulated guys. The most practical method of preserving these high insulation values yet devised is that of using wood strain insulators.

However, any wood strain insulator which considers only the providing of adequate lightning flashover protection and under-rates the importance of long-sustained mechanical strength is of doubtful value, to say the least.

O-B Wood Strain Insulators have been designed and are manufactured with both of these worth-determining factors, high insulation value as well as long-sustained mechanical reliability, fully in mind. Laboratory tests demonstrate the former, a study of the O-B Grip design, the latter; while the outstanding performance of ten thousand O-B Wood Strain Insulators now in service offers important evidence of both.

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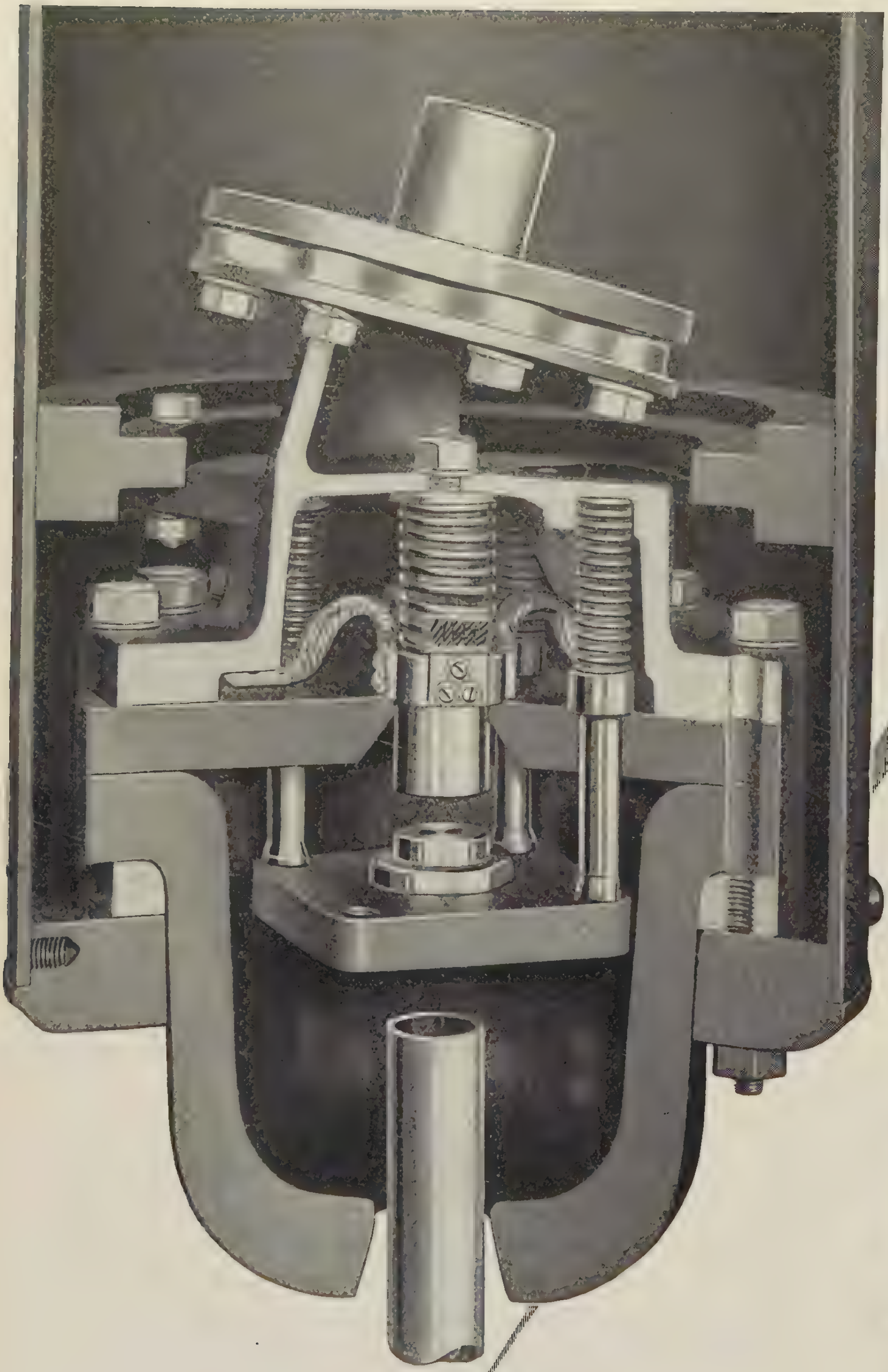

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THIS development is the most recent improvement in the construction of oil circuit breakers. And how effective! A blast of oil and the arc is out. Indeed, it is so successful in performance that its use is synonymous with system stability.

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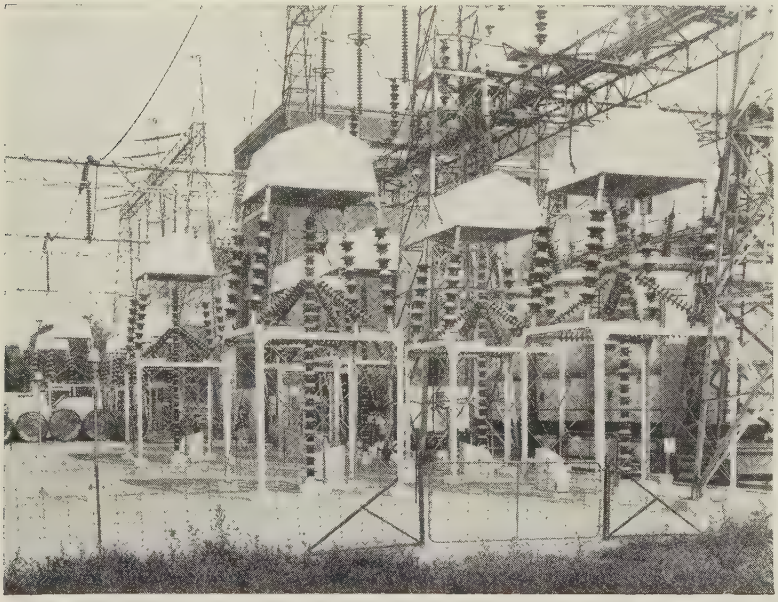

Four 268-kv. Westinghouse SV Autovalve arresters installed at the Leaside Transformer Station of the Hydro-electric Power Commission of Ontario, Canada. These arresters are the largest ever built. Some idea of their size will be realized from the fact that each sphere-gap hood will house a small car, being eight feet wide by nine feet long and six feet, six inches high.

THE highest-voltage lightning arresters in the world are installed at the Toronto Leaside Transformer Station of the Hydro-electric Power Commission. While these SV Autovalve arresters have a normal rating, from line to ground, of 218 kv., an automatic device* will change this rating from 218 kv. to 268 kv. to provide for overvoltage should the generators run away. Each phase leg of the arresters is equipped with a disconnecting switch which opens automatically when the dynamic voltage rises above a critical point. The switch in opening inserts four additional arrester units in each phase leg, making a total of 22 units between each phase wire and ground.

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*Can be used only in those hydro-electric systems where the rate of dynamic-voltage rise is determined by the increase in speed of the hydro unit during loss of load.

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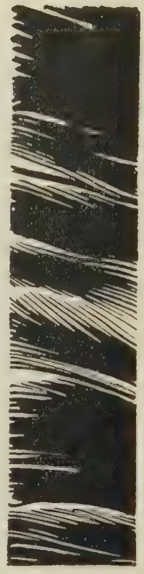

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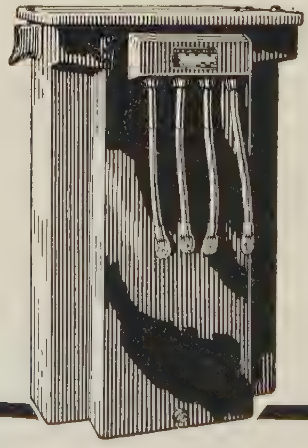

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A switch cubicle in the making

—using DOSSERT Terminal Lugs

There are twelve standard Dosserts for connecting cables, stranded or solid wires, rods and tubing.

These cover nearly every requirement in modernizing station and substation layout.

The Dossert book describes these and gives all necessary data on wires and cables on which they are to be used.

It also illustrates special connectors (using the Dossert Tapered Sleeve principle) on which the Dossert plant is always willing to cooperate with engineers.

A copy will be sent you on request.

OTHER CONNECTIONS

Main High Tension Bus:
Dossert Cable Taps.

Oil Switches:
Dossert Stud Connectors.

Transformers:
Dossert Lugs and Cable Taps.

Rotaries:
Dossert Lugs, Offset and Straight Through Types.

Starting Bus:
Dossert Cable Anchors and Dossert Cable Taps.

DOSSERT & CO., **H. B. Logan, Pres., 242 W. 41st St., New York**

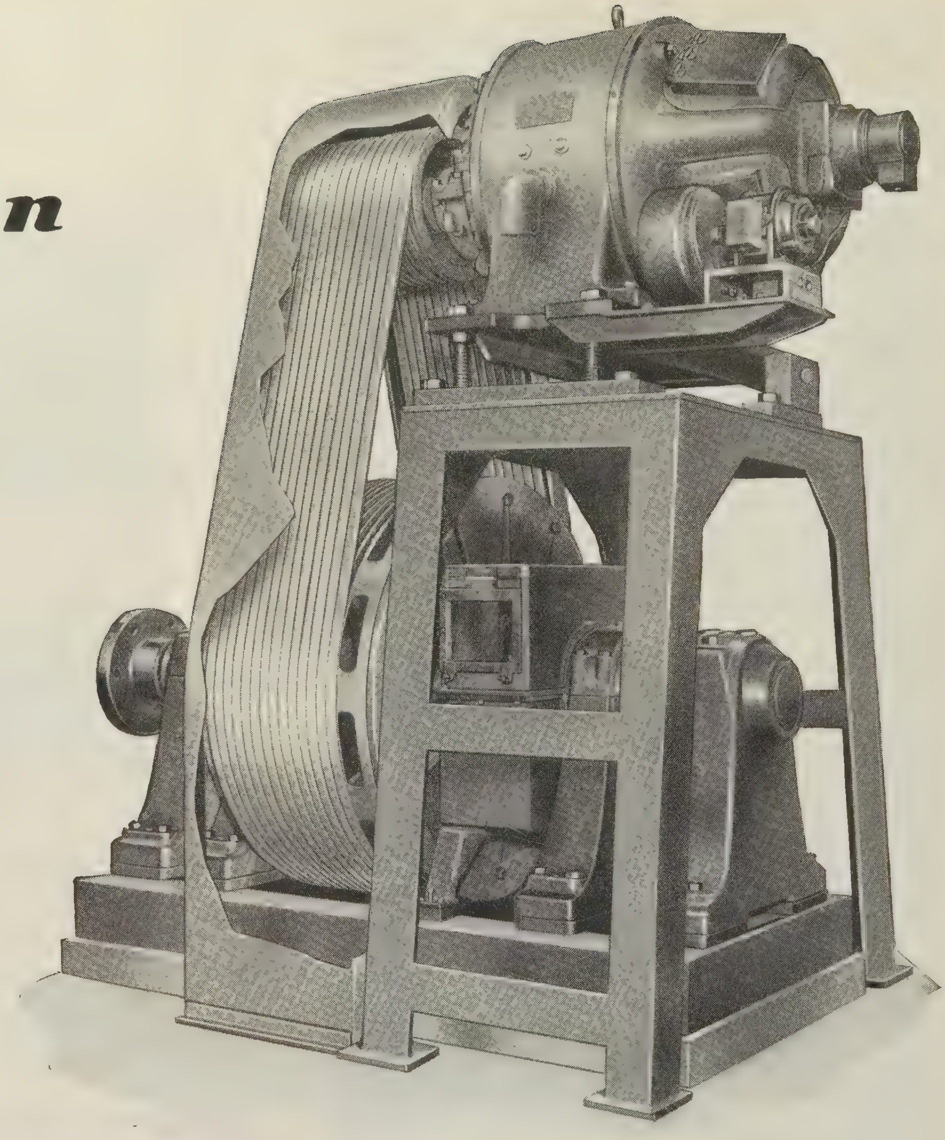
It's a

DOSSERT

Rossman System

Adjustable Speed Control with High Efficiency

—for alternating current drives



Rossman drives are used for variable torque work such as induced or forced draft fans, centrifugal boiler feed pumps, condenser pumps, etc., and for constant torque work such as coal crushers, plunger pumps, etc.

Allis-Chalmers Rossman drives for operating forced and induced draft fans at the station of the Super Power Company of Illinois, Powerton, Illinois, have a speed range of 2½ to 1 with speed adjustments made in such small increments that the effect is substantially a smooth speed curve throughout the entire range of the control, irrespective of changes in the load.

No power is dissipated in resistance units for low speed operation. Speed variation is obtained by rotating the stator or primary member of an induction motor either backwards or forwards.

Higher efficiency is obtainable with this system than from slip ring induction motors with external resistance, two-speed induction motors, or the Ward Leonard System of speed control.

The Rossman System is simple, reliable, and efficient, with no complicated machines or connections.

Write for details.

ALLIS-CHALMERS

MILWAUKEE, WIS. U.S.A.

SHUNT WOUND
BATTERY CHARGER

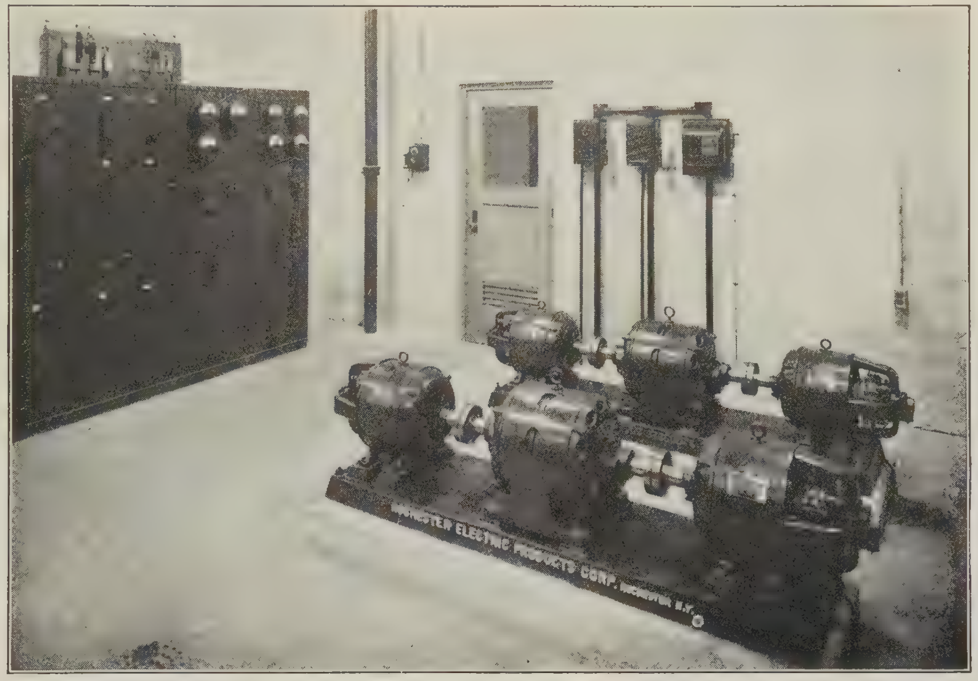
THE ELECTRIC PRODUCTS COMPANY
PATENTED
JAN. 1926
CLEVELAND, OHIO. U.S.A.

THE DIVERTER POLE GENERATOR

CONSTANT
VOLTAGE INHERENT

RUNS AS
MOTOR SAFELY

FOR ALL KINDS OF BATTERY CHARGING—WITH SAFETY & ECONOMY



Diverter Pole generator sets as installed in the Leaside substation of the Hydro Electric Commission of Ontario. Generator on the right is floating with 120 cell battery on main bus control, and generator on the left is floating with 24 cell battery on supervisory control.

FEATURES

During breaker operation the generators share the load with the storage batteries, help maintain the voltage and assure snappy action

During power interruption the generators motorize, and on return of power come back promptly to the original voltage without manual adjustment.

At all times the charging rate is regulated by the counter E. M. F. of the battery. There is no danger of either over or under charging.

Also manufacturers of Low Voltage Electroplating Generators, variable speed D. C. Motors and Motor-Generators of all kinds.

The Electric Products Co.

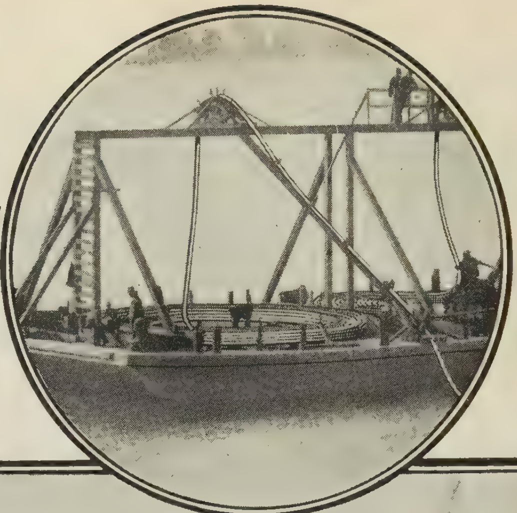
CLEVELAND, OHIO

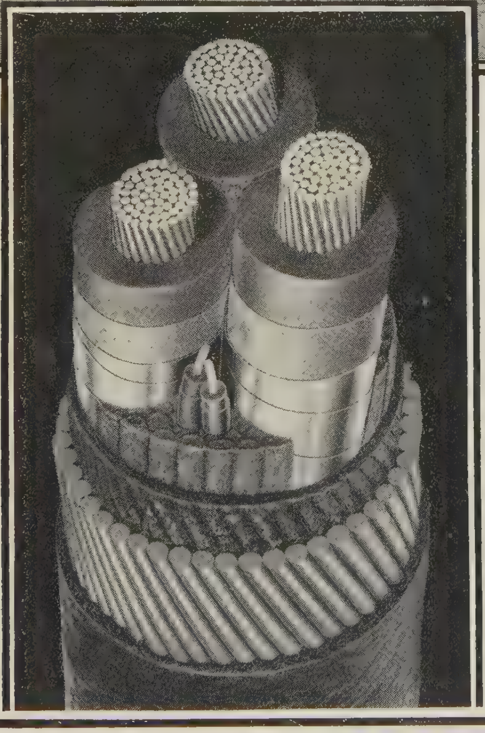
1725 Clarkstone Road

New York Office 126 Liberty St.

Achievement
in Submarine Cables

Laying parallel and simultaneously three Submarine Cables across the Mississippi River at Davenport, Iowa, for the Peoples Power Company. Each Cable of the leadless three conductor type, four inches in diameter and one mile in length, operating at 15,000 volts.





THE development of submarine cables to meet every need—to render far longer service and assure the greatest efficiency of transmission—has been the constant aim of the American Steel & Wire Company.

Back of these outstanding products are years of wire making experience—and this is apparent in superior engineering service—reasonable cost, and proved quality.

No matter what your electrical problem may be—whether you need standard or special cables for submarine, overhead or underground use, you will find us ready to serve you efficiently and economically. We make cables in any quantity, of any size or type and for any voltage, to meet the most rigid specifications.

AMERICAN STEEL & WIRE COMPANY

SUBSIDIARY UNITED STATES STEEL CORPORATION

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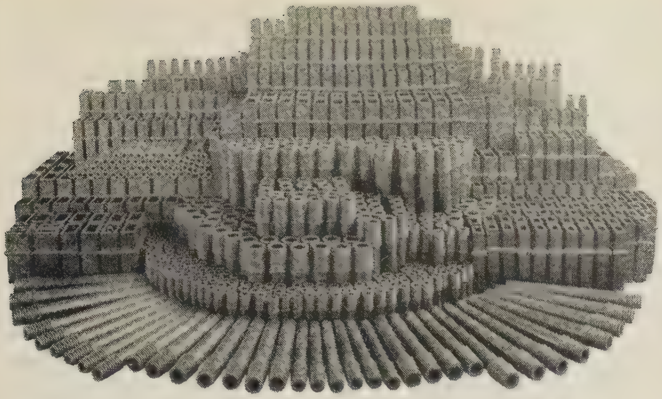

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Wall and *Floor* Entrance Bushings

run straight and uniformly true to size

BURKE—Wall and Floor Entrance Bushings are formed in steel molds under enormous pressure. This process of manufacture insures a homogeneous product exceptionally free from defects.

BURKELECT—is the compound used. It embodies electrical and mechanical qualities, which make it particularly well suited for use as an insulating medium.

A power arc, which will shatter porcelain, will cause Burkelect to burn, but only as long as the arc is maintained. BURKELECT will not sustain combustion. The carbonized surface resulting from power arcs may be cleaned, and the Bushing thus restored to its original value.

See Bulletin H-1.

HIGH TENSION EQUIPMENT

BUS BAR CLAMPS
CABLE CLAMPS
TERMINAL LUGS
LEAF TERMINALS
END CONNECTORS
BRACING CLAMPS
CONNECTORS
JUNCTION BOXES
EXPANSION JOINTS
MOULDED INSULATION
TERMINAL BLOCKS

Genuine Bakelite CONTROLEAD TERMINAL BLOCKS

Built in three styles, five sizes
Bulletin H-2.

BURKE CONNECTORS

All styles—made in copper or aluminum
Bulletins H-3 and CT-4.

BURKE
ELECTRIC COMPANY
main office and works: ERIE, PA.
SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

MANUFACTURERS OF
ALTERNATING AND DIRECT CURRENT MOTORS AND GENERATORS, MOTOR GENERATOR SETS, ARC WELDING EQUIPMENT, UNIVERSAL MOTORS, COPPER CONNECTORS, MOULDED BURKELECT INSULATORS, CONTROLEAD TERMINAL BLOCKS

Who needs . . . WIRE like this?

IF the wiring in your plant or product is exposed to the attack of

1. Heat (moist or dry)
2. Fumes or vapors
3. Oil or grease
4. Acids or
5. Fire hazard

you can eliminate the outages these conditions cause by using a type of insulated wire which is entirely unaffected by them. Write us briefly about troublesome conditions of this sort and we will submit samples of corrective wire and specific suggestions to do away with the troubles. Please fill in the coupon below and send it with your letter.

All ordinary types of insulated wire have a definite rate of deterioration. This is accelerated when the wire is exposed to the various conditions mentioned. For instance, heat vulcanizes and oil and grease rot rubber insulation and fumes eat fabric coverings.

Now asbestos, which has lain in the ground in a constant state for thousands of years during which time it has successfully resisted all these conditions, makes the ideal insulation because it is unaffected within wide limits by any of these deteriorating elements.

This means that you can confidently wire with the proper type of asbestos insulated wire with the full knowledge that the wiring is permanent even under severe operating conditions.

In the case of equipment, the correct type of wire helps eliminate one source of customer dissatisfaction by cutting down returns due to wire failure.

If you are facing any such conditions let us be of help to you. There is no obligation in inquiring. Perhaps better operation or appreciable savings will result. Please write:

ROCKBESTOS . . The Wire with permanent insulation . .

ROCKBESTOS PRODUCTS
CORPORATION
378 NICOLL STREET NEW HAVEN, CONN.

Please send samples of a wire which will successfully resist.............................. See additional data on attached sheet.

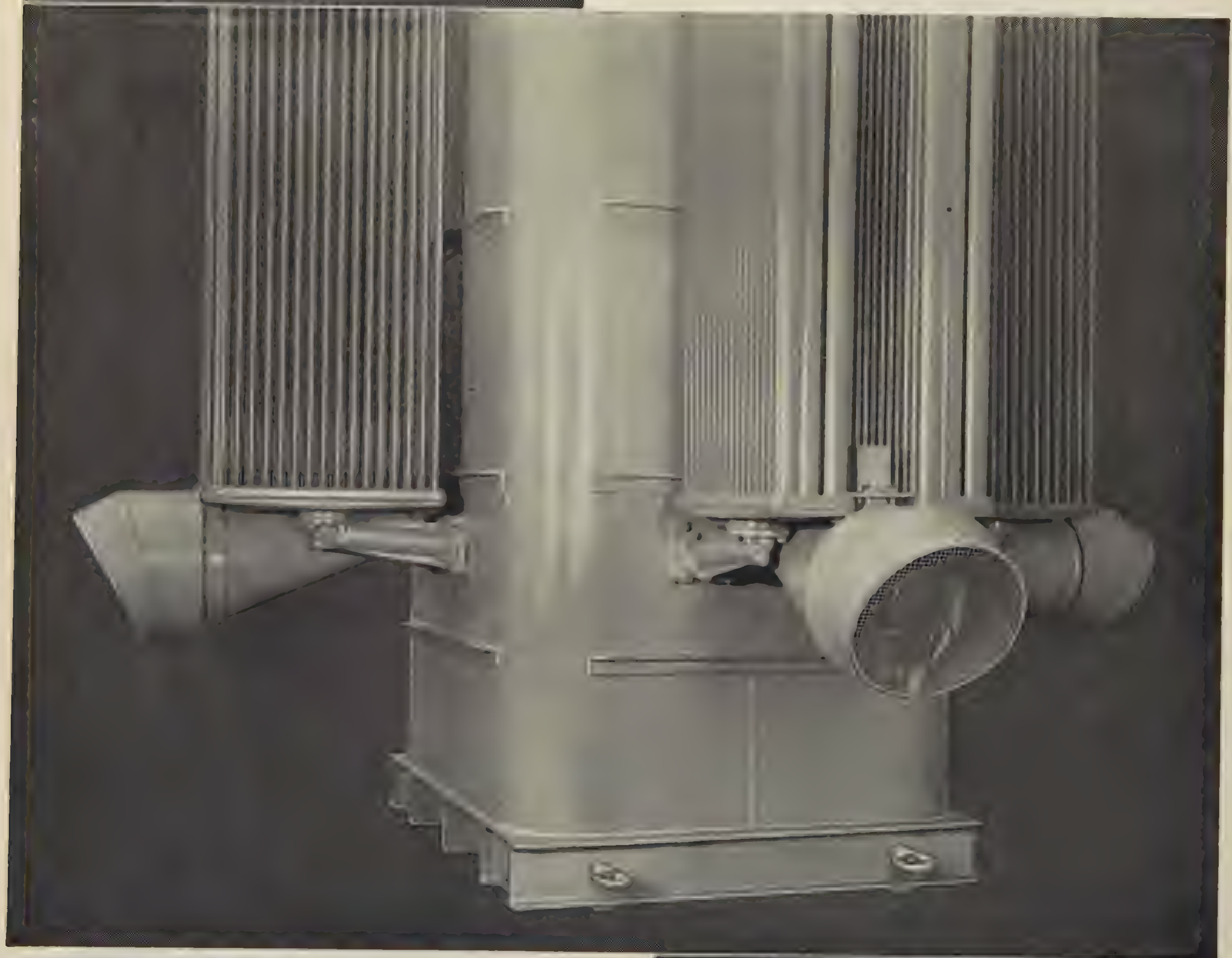
Name..............................Title..............

Company..

Address..

Dual-Rated Transformers

Wagner also manufactures oil-filled power transformers equipped with air-blast cooling systems for materially increasing the nominal self-cooled rating for heavy peak-load periods « « « « The Wagner air-blast cooling system consists of blower, casing and control equipment. The blower furnishes large volume of cooling air which is directed by the casing along the radiator surfaces. Control equipment consists of a thermostat, the bulb of which is located in the hottest oil. It can be adjusted to any temperature desired over the operating range of the transformer. An open-circuit contactor is used, so that the blower will start and continue running should any of the control wires from the thermostat become broken or removed in error « « « « « « « « « These design and construction details, along with hundreds of others are fully covered in the new Wagner power transformer bulletin No. 170, of which a copy will be sent upon request. « « « « « « « «



Wagner
Electric Corporation

6400 Plymouth Avenue, Saint Louis, U. S. A.

MOTORS TRANSFORMERS FANS

T331-3XA

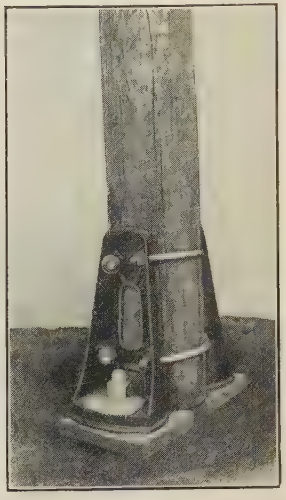
BURNDY CONNECTORS FOR GROUNDING

New Catalog Shows 25 New Types

Write for it

BURNDY ENGINEERING CO. INC
230 EAST 45TH STREET · NEW YORK

POLE MOUNTING SECURITY



Service installations now confirm our original tests indicating an ultimate ground-line resisting moment of 40,000 ft. lbs. for the No. 711 Williams Pole Mount unit illustrated, using poles from 7″ to 11″ in diameter.

With due allowance for salvaging Pole Mount unit itself after years of service, it is as cheap as stubbing and more attractive from public relations angle. Preferable also for supporting new poles on rock, bridges, etc., and for important new construction such as transformer and terminal poles, etc.

Use larger sizes for larger poles and heavier loads, as follows: No. 915 (80000 ft. lbs.), No. 1218 (120000 ft. lbs.), No. 1622 (200000 ft. lbs.). Select pole to carry the load, and then proper Pole Mount unit will anchor pole so as to develop its full strength permanently, undiminished by gradual ground-line decay. Service interruptions and overhead changes eliminated on salvage jobs. Over 5000 successful installations confirm their economy and range of application.

Other M. I. F. Pole Hardware Specialties include: Crossarm Gains, Guy Hooks and Eye Nuts, Cable Suspension Clamps, Insulated Suspension Hangers, Reinforcing and Extension Clamps for tubular steel poles, etc. Send for Bulletins on items of interest.

We feature Engineering Service for special applications.

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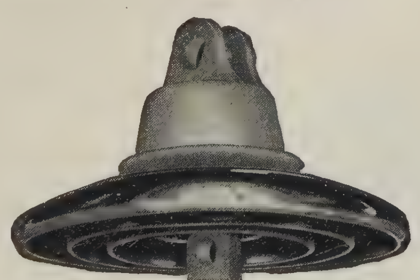
LINE & CABLE ACCESSORIES, Ltd., Toronto

INSULATORS



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HEMINGRAY GLASS INSULATORS

The transparency of Hemingray Glass Insulators makes line inspection very simple. The lineman can tell at a glance whether the insulator is intact or not. Hemingray insulators are mechanically and dielectrically dependable, non-porous and uniform in structure. They defy moisture and age.

Send for Bulletin No. 1.

HEMINGRAY GLASS COMPANY
Muncie, Indiana

NON-RUSTING "COPPERWELD" LINE WIRE

GIVES MORE DEPENDABLE SERVICE

If the breaking loads of Copperweld line wires are compared size for size with the breaking loads of line wires of other materials, it will be seen why telephone lines, when built with Copperweld wire, render more dependable service.

Copperweld wire is non-rusting, its high initial strength is retained year after year.

Copperweld Steel Company
General Offices and Mills
Glassport, Penna.

MINERALLAC
PULLING COMPOUND

(Pulling heavy cable through a clay duct)

It saves the lead sheath, shortens the pulling time and cuts down expense of installation.

MINERALLAC ELECTRIC COMPANY

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Thomas Quality
PORCELAIN INSULATORS
LINE HARDWARE
WIRING PORCELAINS
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An American Standard since '73

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Memco builds this equipment in all standard and special sizes—ask for bulletins of interest to you.

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FUSE-SWITCHES

OTHER KEARNEY PRODUCTS

Screw Anchors—4 in 1 Expansion Anchors—Guy Wire Clips—Double Duty Cutouts—Solderless Wire Connectors—Single Insulator Fuse-Switches—Fuse Choke Coil Combinations—Sleeve Twisters—Live Line Tools and Accessories.

Complete Catalog Sent On Request

JAMES R. KEARNEY CORPORATION
4220 CLAYTON AVE. ST. LOUIS, MO.

ELECTRICAL DESIGN

Terminators are good examples of what scientific research and years of experience in the high-tension field will produce. Research has resulted in an arrangement of petticoats on the insulating bushing, giving higher flashovers for certain bushing lengths with better dry and wet flashover ratios.

It is now unnecessary to make bushings long enough to get the required wet flashover with an inherent high dry flashover. In some cases it may even be detrimental to the cable and system as a whole to have a much higher dry than wet flashover. Too great a bushing may also introduce a high surge impedance, exposing the cable or other equipment to breakdown.

For a more uniform distribution of electrical stresses, graded insulation has proven to be of great benefit to many high-tension electrical devices. A graded insulation on terminators secures a potential distribution approaching the ideal more closely than with older designs.

Bulletins upon request.

Delta-Star Electric Co

2400 BLOCK, FULTON ST., CHICAGO

Engineering
Societies Library

A reference library for engineers—contains 150,000 volumes—receives over 1,300 technical journals and periodicals on all branches of engineering.

Searches are made upon engineering subjects, translations from foreign publications, photostats made, etc.

Books may be borrowed by members of the A. I. E. E. For information address, The Engineering Societies Library, 33 West 39th St., New York.

At Your Service

R&IE introduces—

A new and positive method of FUSE protection

Type
"MED"

For further interesting data, please consult the nearest R & I E Representative or write direct to—

The Railway and Industrial Engineering Company presents a newly perfected fuse which differs radically from anything which has yet been put on the market. The fuse was developed on the lines of a large Power Company and hundreds of them have been in service for several years. The design of this fuse solves one by one the inherent weaknesses of existing fuses and combines their various points of excellence. It has been perfected by more than a year of experiments both in the laboratory and in the field. The tests made have included loads ranging from a fraction of an ampere to short circuit currents of several thousand amperes.

RAILWAY AND INDUSTRIAL ENGINEERING COMPANY
GREENSBURG, PA. - - - - - - *sales offices in all principal cities*

Corona Prevention and Ozone Elimination with ---

TRADE **ANOROC** MARK

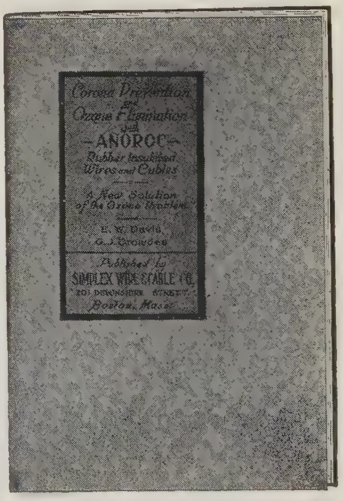
Rubber Insulated Wires and Cables

"Corona Prevention and Ozone Elimination with Anoroc Rubber Insulated Wires and Cables" is a new and interesting 20 page booklet containing description of tests and giving data on the latest Simplex product, Anoroc Rubber Insulation for high voltage wires and cables.

Anoroc rubber insulation absolutely prevents the formation of ozone in or about a cable at normal operating voltage, making all ozone proof or ozone resisting qualities superfluous. It removes the only objection to rubber insulation for high voltage conductors and retains all of the electrical, chemical and physical characteristics which have made rubber the most adaptable and desirable insulation for cables.

Anoroc rubber insulated cables are designed to meet specific operating conditions and are insulated to stand a 35% over-voltage without danger of corona forming.

The efficacy of this method of protecting cable insulation from ozone has been amply demonstrated by laboratory tests fully substantiated by actual service under operating conditions.



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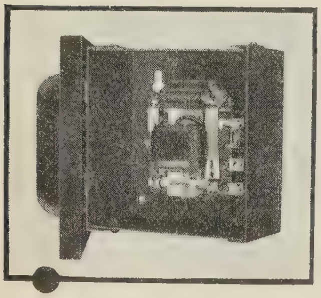
PHILADELPHIA, 1227 Fidelity-Philadelphia Trust Building
JACKSONVILLE, 417 Barnett National Bank Building

SIMPLEX WIRE & CABLE CO., 201 Devonshire St., Boston, Mass.
Please send "Corona Prevention and Ozone Elimination," to
Name ....
Address ....
Title ....
Company ....
City .... State ....

SIMPLEX INSULATED WIRES AND CABLES

14 STANDARD FEATURES

AND THEN ADD - ECONOMY



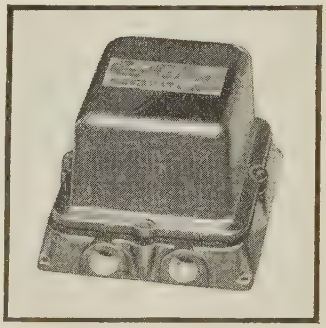
Ward Leonard Relay Mounted in Pressed Steel Box Provided with Mounting Holes and for Conduit Connections.

IN selecting equipment to meet the requirements of automatic or remote control problems, the critical buyer demands relays which will "more than do the job." Often satisfactory performance over a period of years depends just as much upon details of construction as upon correct basic design. And to Ward Leonard, the manufacture of relays is much more than a matter of efficient basic design.

Perfection of detail is the added factor in Ward Leonard relays. Listed among the 14 standard features in Bulletin 81,000 are the fine points of design and construction which satisfy every requirement of the critical buyer.

Send for a copy of this bulletin today. It describes in detail Ward Leonard Magnetic Relays for A. C. and D. C., methods of mounting, and methods of control.

Specially Designed Coils Used in All Ward Leonard Relays Keep Watts Loss to a Minimum, thereby Conserving Valuable Power. Below:— Ward Leonard Relay Mounted on Cast Aluminum Base with Cast Aluminum Cover.



WARD LEONARD ELECTRIC CO., MOUNT VERNON
NEW YORK

WARD LEONARD MAGNETIC RELAYS

Motor control that is independent of weather

THERE'S no need to worry about the placing of equipment, if you're figuring on Rowan oil immersed Control.

Mount it right out in the weather, if you like; rain, snow or excessive heat have no effect upon its operation. Place it on the wall of the vat room where vapor or corrosive fumes envelop it every day—you can rely upon its dependable performance no matter where it is placed.

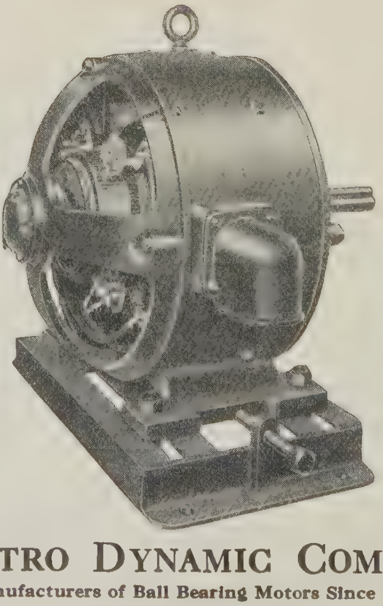
Rowan oil immersed Control is weather proof, dust-tight, vapor proof—ruggedly built for service in plants where uninterrupted operation is imperative and production delays costly.

Bulletins and prices of Rowan Control equipment promptly sent upon request.

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

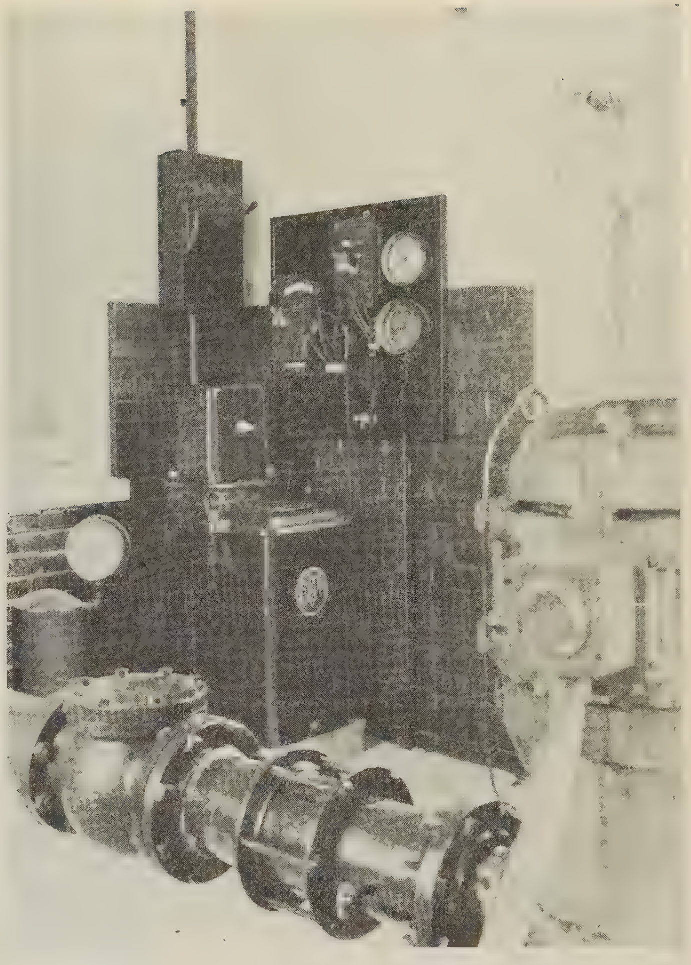
The Pioneer Manufacturer
— of —
Interpole & Ball Bearing Motors

½ to 1000 H. P. D. C. and A. C.



Type "S" Ball Bearing Motor

ELECTRO DYNAMIC COMPANY
Manufacturers of Ball Bearing Motors Since 1904
BAYONNE, N. J.
Sales Offices in Principal Cities
"Quality for Half a Century"



An example of how EC&M Control Engineering and Control apparatus helped to solve an automatic pumping problem.

AIR POCKETS Can't Damage this Deep Well Pump

On any deep well high lift centrifugal pumping installation, the entrance of air into the pump line caused by recession or lack of water, would damage the impellers of the pump, if it was allowed to run for any length of time under these conditions.

To eliminate this happening which would necessitate costly repairs and possible deprivation of water supply for this municipality of Eastern Pennsylvania, EC&M Control Engineers solved the problem by making the pump inoperative should the water fall below a certain level in the well, or should air pockets get into the pipe line.

Under ordinary conditions, the pump is controlled automatically through an EC&M Altitude Regulator, Cushion Tank and an EC&M Automatic Starting Compensator. However, a constant check is kept on the low water level by an EC&M Pressure Gauge, so that if the water is pumped below a certain level, the contacts of this pressure gauge open and break the circuit to the EC&M Altitude Regulator, thus shutting the pump down until the water level has again reached a safe height.

Our nearest branch office will be glad to give you the benefit of EC&M Control Engineering on any problem you may have.

THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND, OHIO

NEW YORK-50 CHURCH ST.,
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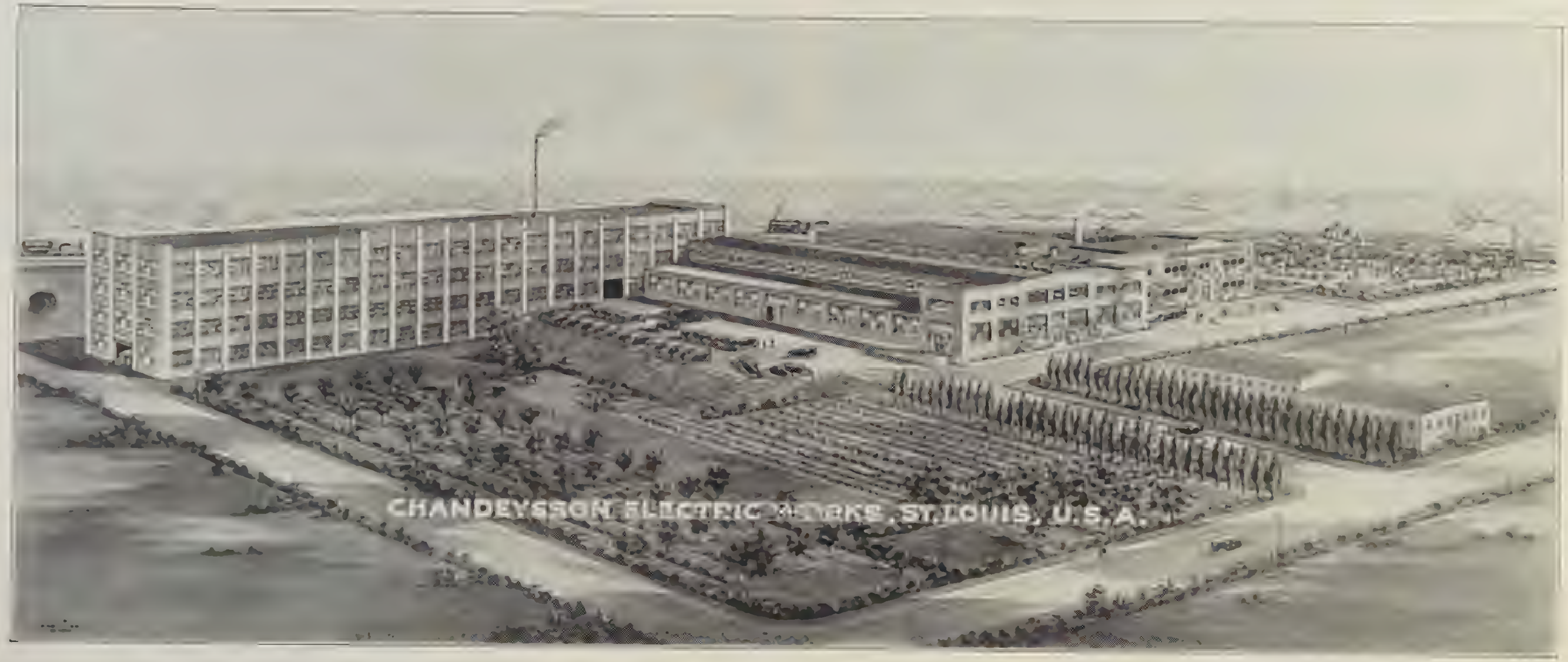
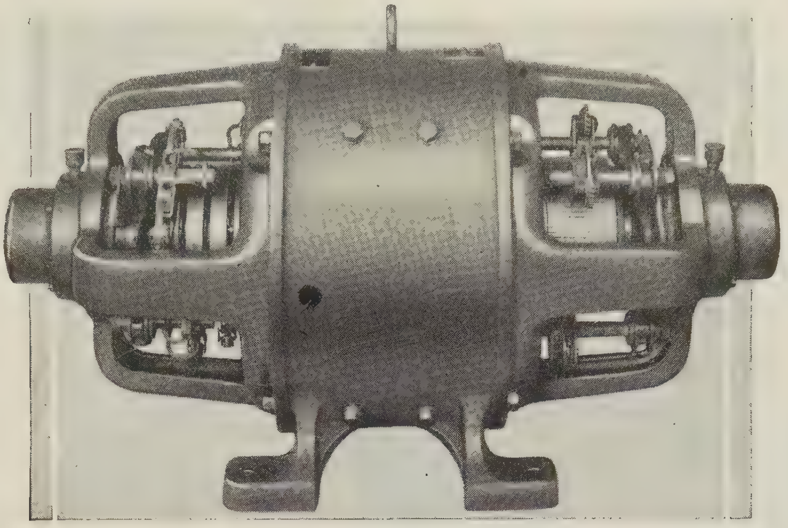

CHANDEYSSON ELECTRIC WORKS, ST. LOUIS, U.S.A.

COME AND SEE HOW
WE BUILD AND TEST PLATING GENERATORS

THEY KEEP A-RUNNING



Century-Roth Inverted Rotary Converter—50 Volt Amperes to 20 K.V.A.

INVERTED ROTARY CONVERTERS

Using direct current as a source of supply, Century-Roth Inverted Rotary Converters will deliver alternating current—either single phase, 3 phase or 4 phase, of the frequency and voltage required—for the operation of Gaseous Tube Signs, Spot Welding Machines, Telephone Exchanges, X-ray Equipment, Radio Power, Public Address Systems, etc.

They are built in sizes from 50 volt amperes to 20 K.V.A. . . . The 50 to 200 volt ampere converters are furnished with phosphor bronze sleeve bearings equipped with the Century Wool Yarn System of Lubrication . . . The .25 to 20 K.V.A. sizes are furnished with grease lubricated ball bearings, although sleeve bearings can be furnished . . . Screen enclosing covers can be supplied when required on the .25 K.V.A. and larger sizes.

ROTH BROTHERS AND COMPANY
Division of Century Electric Company
1400 W. Adams St. » » » » Chicago, Illinois

SINGLE PHASE, THREE PHASE, AND DIRECT CURRENT MOTORS

Century MOTORS

MOTOR GENERATOR SETS, ROTARY CONVERTORS, FANS AND VENTILATORS

RC-I

FOR MORE THAN 27 YEARS AT ST. LOUIS

ELECTRITE

A high grade fibre board for electrical insulation.

A material of quality possessing high tensile and dielectric strength.

Tested and approved by the Underwriters' Laboratories.

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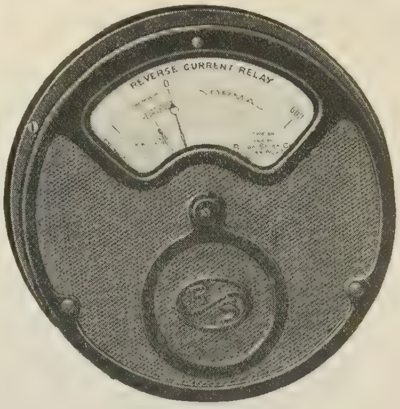

A NEW R-S BULLETIN

New R-S Bulletin No. AE-550 describes a wide variety of relays for a wide variety of applications. . . . . Send for your copy.

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Electrical Measuring and Protective Apparatus

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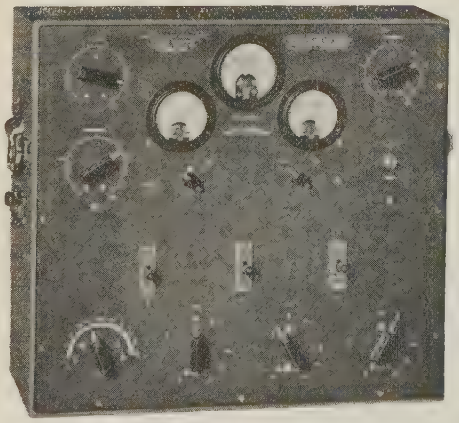

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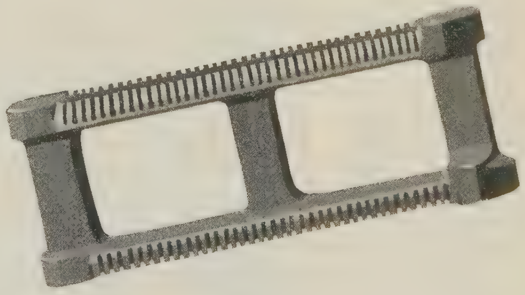

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Synonymous words whenever an insulator is needed.

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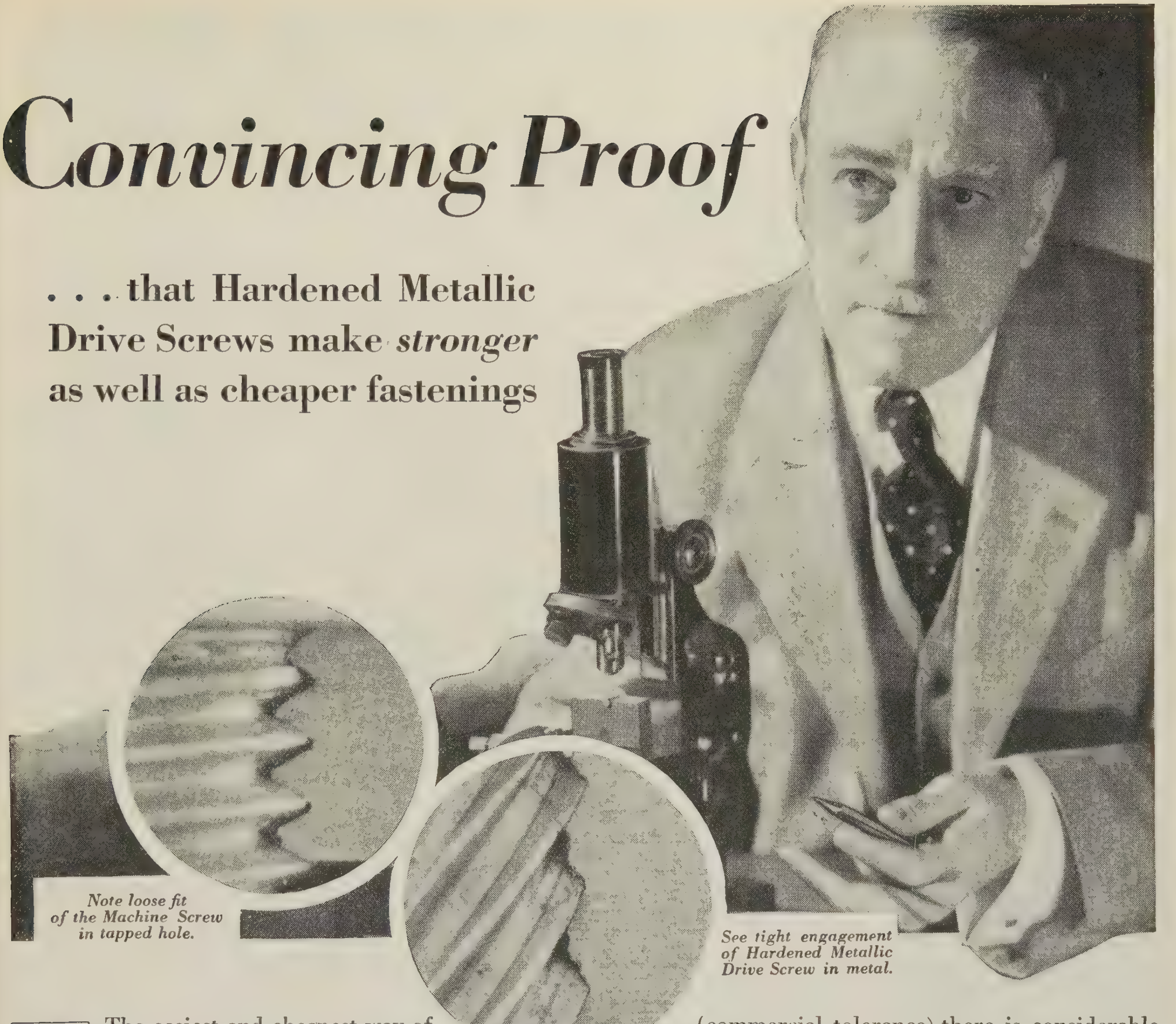
. . . that Hardened Metallic Drive Screws make *stronger* as well as cheaper fastenings



Note loose fit of the Machine Screw in tapped hole.

See tight engagement of Hardened Metallic Drive Screw in metal.

The easiest and cheapest way of making permanent fastenings is also the strongest. Merely hammering Hardened Metallic Drive Screws into holes, drilled or formed in iron, brass and aluminum castings, steel or Bakelite, makes better fastenings than those made with machine screws or bolts and nuts. This is proven by comparative laboratory tests conducted by unbiased authorities.

A convincing explanation of the greater holding power of a Hardened Metallic Drive Screw under vibration, the chief cause of fastening failure, is offered by the microscope. Remembering that the security of a fastening under vibration depends upon how tightly the Screw threads are engaged in the metal, look at the unretouched microphotographs here. It is easy to see why the Hardened Metallic Drive Screw holds better.

Note how this unique Screw forms a thread in the metal as it is driven . . . how that action embeds the screw threads so firmly in the metal that screw and metal are practically one. Then observe that between the machine screw threads and the tapped threads (commercial tolerance) there is considerable space . . . space which permits the machine screw to loosen under vibration.

Under stresses of tension and shear, a stronger fastening is obtained with a Hardened Metallic Drive Screw because it possesses greater tensile strength than an ordinary screw, being made of a special steel, scientifically treated.

The booklet offered here shows how users of these Screws effect substantial savings through elimination of slow and costly tapping, fumbling with bolts and nuts and other assembly difficulties. Use coupon to obtain it.

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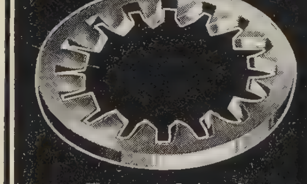

Type 12. *Internal*
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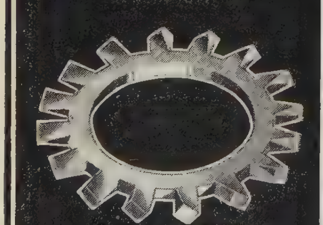

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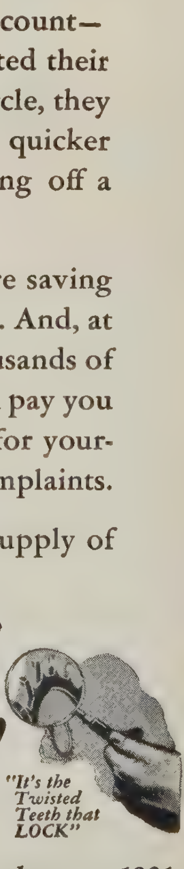
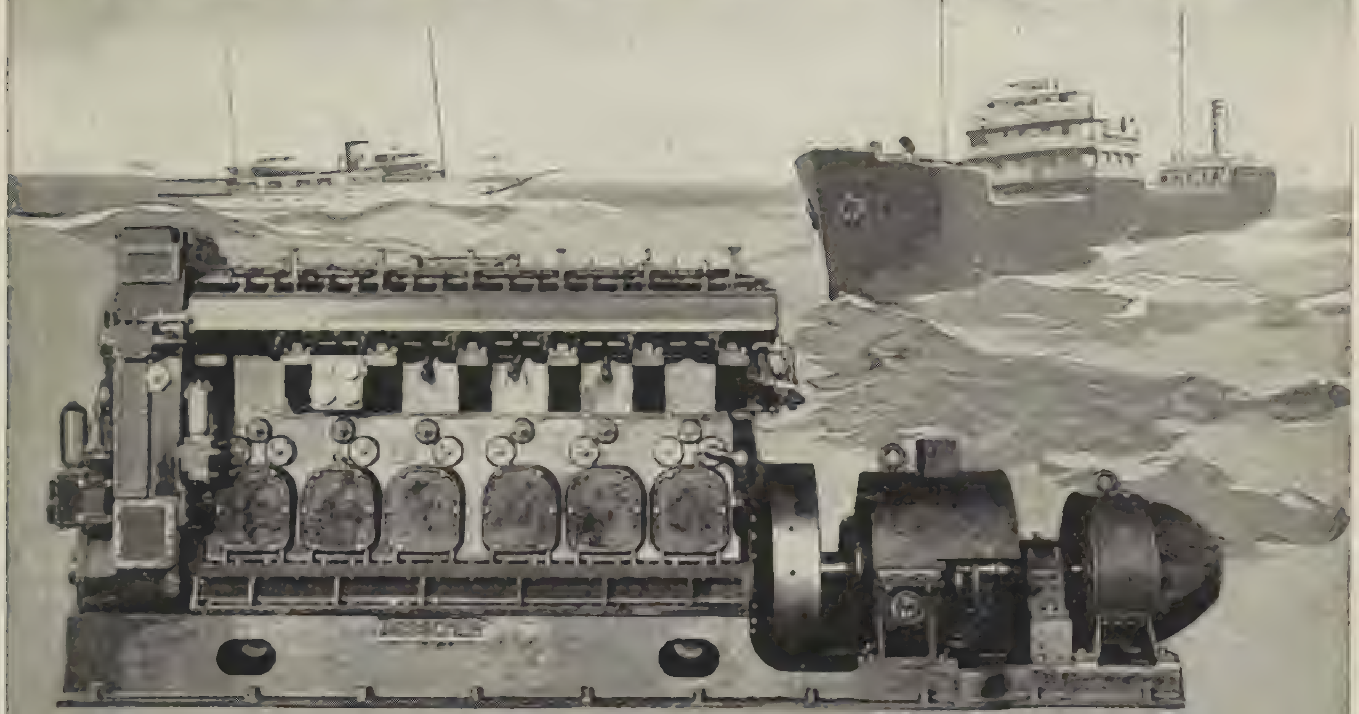
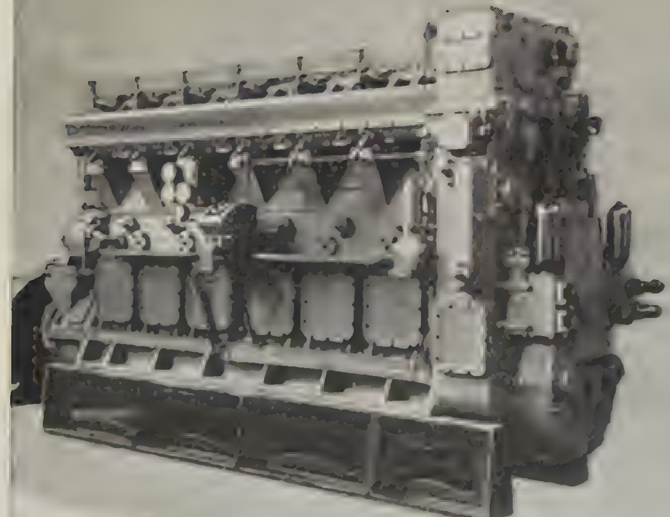


"It's the Twisted Teeth that LOCK"

FOR DIESEL ENGINES





The upper illustration is a Cooper-Bessemer Diesel engine-generator unit for the tanker "Tidemotor" of Tidewater Oil Co. The lower picture, another Cooper-Bessemer unit in the private yacht of Mr. George L. Craig, Long Beach, California.

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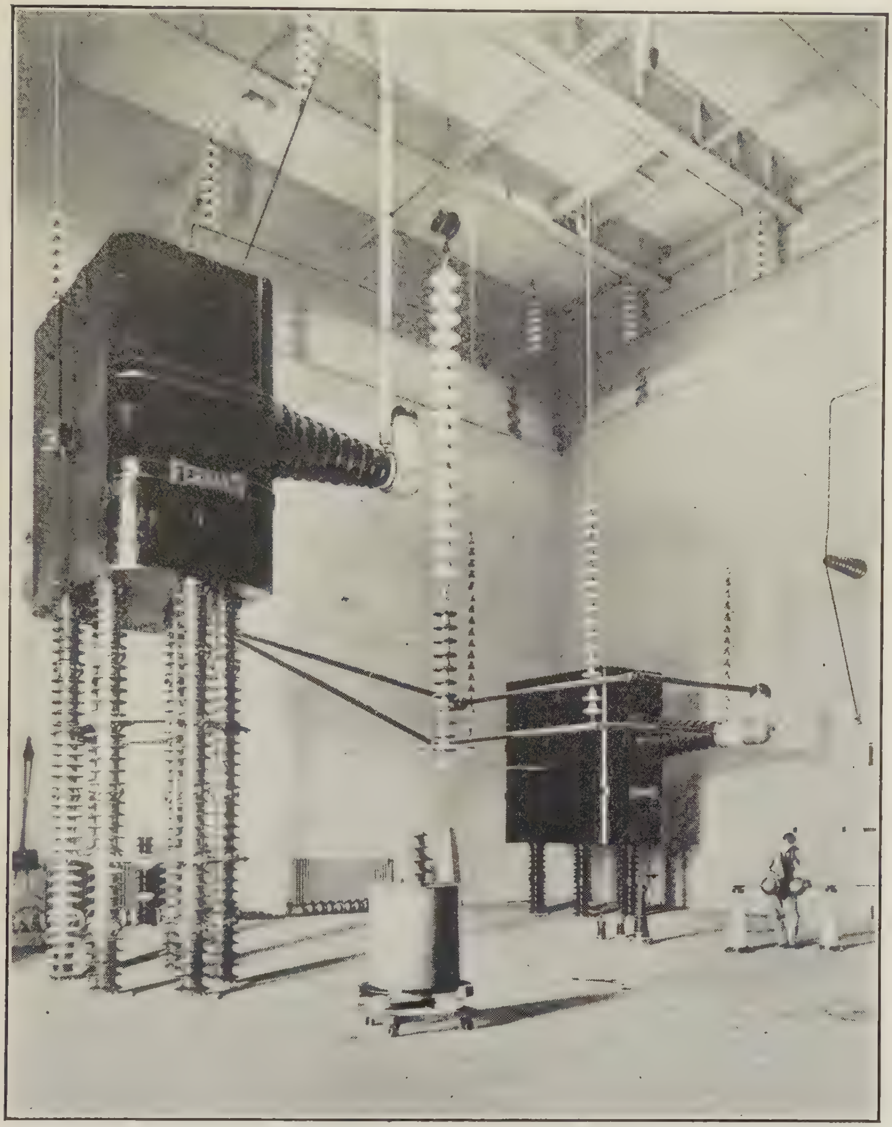

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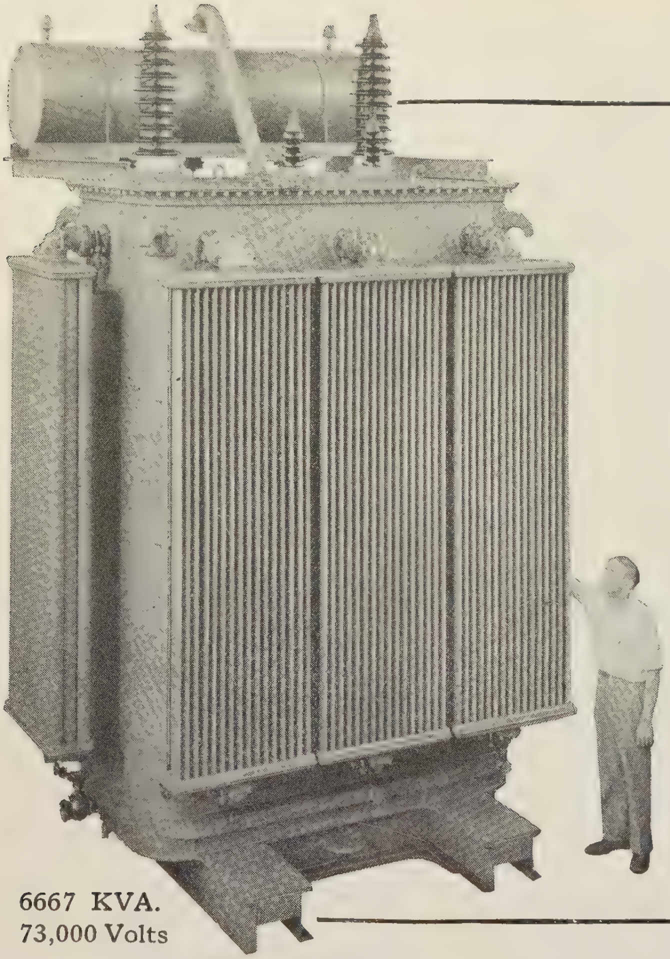

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WHAT IS THE

A·T·&·T·?

ALL that most people see of the telephone company are a telephone and a few feet of wire.

But through that telephone you can talk with any one of millions of people, all linked together by the web of equipment of the Bell System.

All its efforts are turned constantly to one job —to give better telephone service to an ever-increasing number of people, as cheaply as it possibly can.

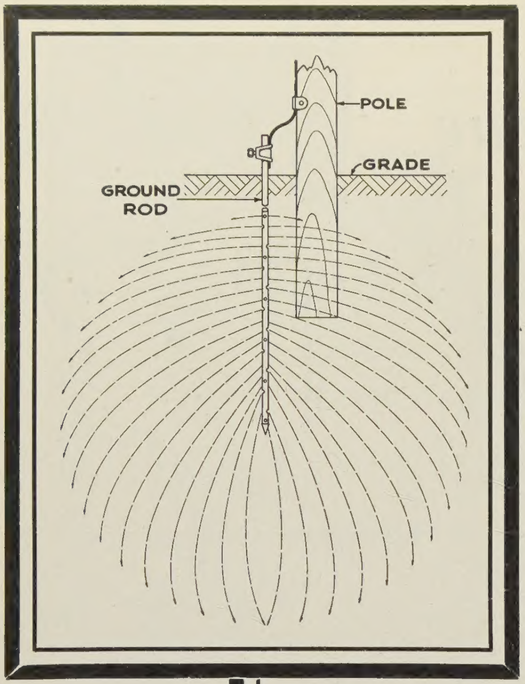
The American Telephone and Telegraph Company provides the staff work for the Bell System. To it the operation of the telephone service is a public trust. It pays a reasonable dividend to its stockholders . . . and uses all earnings beyond that to improve and extend the service.

There are more than five hundred and fifty thousand stockholders, and no one person owns so much as one per cent of its stock.

The Bell System operates through 24 regional companies, each one attuned to the needs of its particular territory. In addition, the 5000 members of the Bell Laboratories staff do the scientific work which makes it possible to improve and widen the service at least cost to its users. The Western Electric Company, which manufactures for the Bell System, specializes in the economical production of telephone equipment of the highest quality.

All these facilities are directly available throughout the entire Bell System, at any time or place. . . . Because of them, every dollar that you spend for telephone service brings you constantly greater value and convenience.

★ *AMERICAN TELEPHONE AND TELEGRAPH COMPANY* ★



Why Test the Ground?

It is generally agreed at present that the lower a ground resistance the safer and quicker will be the clearing of a system disturbance. Thus it is important to know the value of the resistances at certain important grounding points.

Why Treat the Ground?

Within certain economic limitations low ground resistances may be obtained by treating the soil around a ground whereby suitable low resistance may be obtained.

Why MURRAY Copper Tube Grounds?

Murray Copper Tube Ground Rod

This ground rod provides for economic low cost treating in order to regulate ground resistance values suitable to certain operating conditions. Whichever treating solution is considered best or cheapest, is poured into the copper tubing where it dissipates into the surrounding soil through the treating holes. No longer is it necessary to treat the soil external to the rod.

It provides a permanent ground—and the method is a straightforward, simple and positive one.

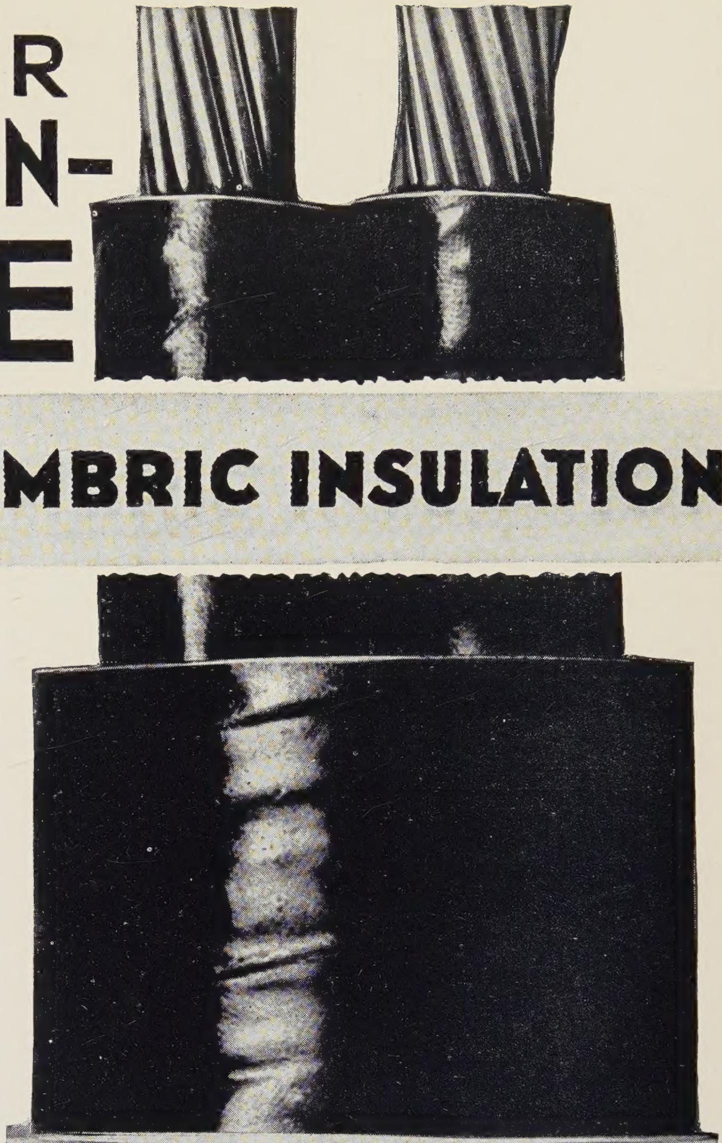
Eight-Page Booklet Contains Additional Information—Chart and Test Data

METROPOLITAN DEVICE CORPORATION

**1250 ATLANTIC AVENUE
BROOKLYN — NEW YORK**

THE OTHER QUALITY TWIN-OKONITE

VARNISHED CAMBRIC INSULATION



FIFTY years of service have established the reputation of Okonite rubber insulation for absolute qualilty.

Okonite Varnished Cambric Insulated Cables have been installed in enormous numbers and for every kind of work, and their performance has been comparable to that of their twin product, Okonite Rubber Insulated Cables.

Okonite Varnished Cambric Cables exemplify the way that The Okonite Company progresses with the Electrical Industry, perfecting and producing the kinds of insulated wires and cables needed to meet the expanding requirements of plant construction and operation.

OKONITE PRODUCTS

Okonite Insulated Wires and Cables	Varnished Cambric Cables
	Manson & Dundee
Okonite Insulating Tape	Friction Tapes
Okocord	Okoloom

OKONITE-CALLENDER PRODUCTS

Impregnated Paper Cables
Super-tension Cables
Splicing Materials

THE OKONITE COMPANY
Founded 1878
THE OKONITE-CALLENDER CABLE COMPANY, INC.
Factories: Passaic, N. J. Paterson, N. J.

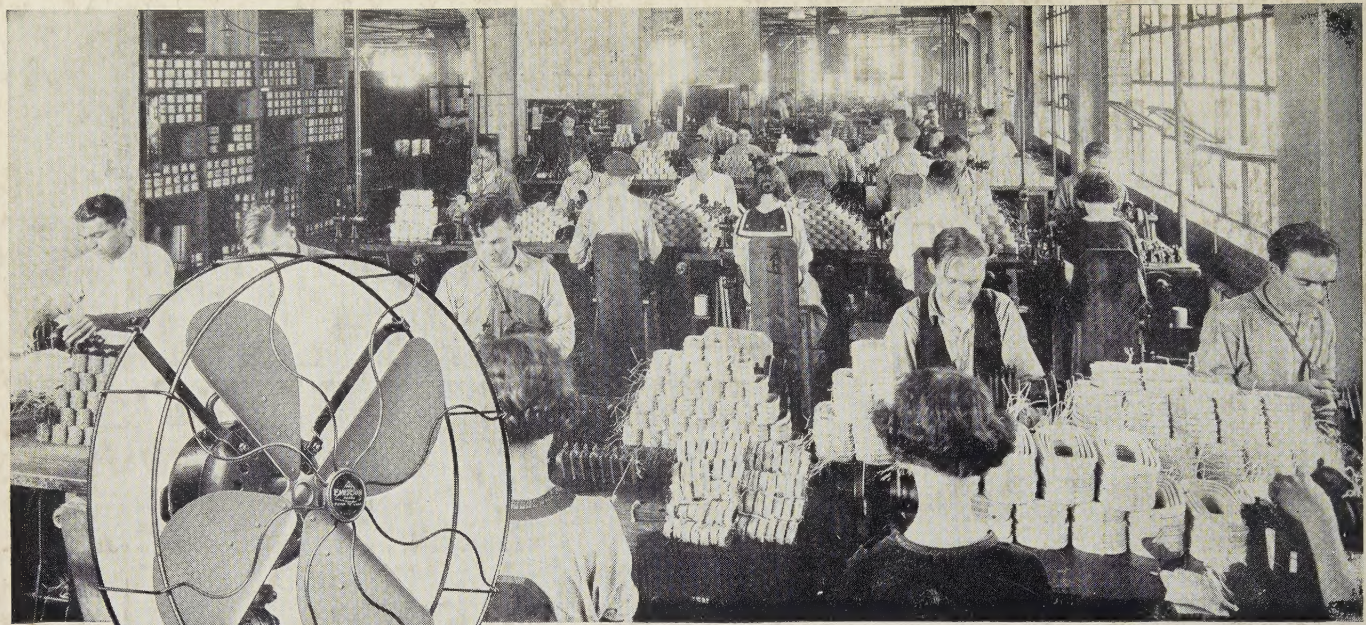
SALES OFFICES:
NEW YORK CHICAGO PITTSBURGH ST. LOUIS
BOSTON ATLANTA BIRMINGHAM SAN FRANCISCO
LOS ANGELES SEATTLE DALLAS

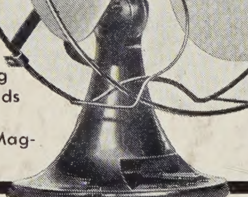
Novelty Electric Co.
Philadelphia, Pa.

F. D. Lawrence Electric Co.
Cincinnati, O.

Canadian Representatives: Engineering Materials, Limited, Montreal
Cuban Representatives: Victor G. Mendoza Co., Havana

OKONITE QUALITY CANNOT BE WRITTEN INTO A SPECIFICATION





The Emerson Electric Manufacturing Company winds motors with Beldenamel Magnet Wire

Is Yours a Quality Product?

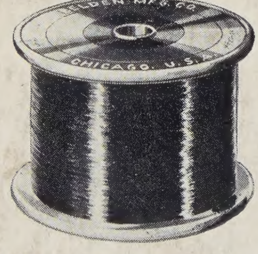
Then wind it with BELDENAMEL

BELDENAMEL and its associates — Cotenamel and Silkenamel — are magnet wires of superlative qualities. Not only is extreme care used in drawing these conductors in our wire mill, but the work of applying the many coats of Beldenamel insulation is a manifold process built around a secret formula.

No other enameled magnet wires are so rigidly inspected as Beldenamel—Cotenamel—or Silkenamel. This inspection and our complete control over the making and applying of Beldenamel assures unequalled uniformity of size and insulation.

Emerson Fans and Motors — like other famous products built to high standards of quality — use large quantities of Beldenamel Magnet Wire in their windings. If yours is a quality product, follow their example. Wind it with Beldenamel.

Belden Manufacturing Company, 4631 W. Van Buren Street, Chicago, Ill.

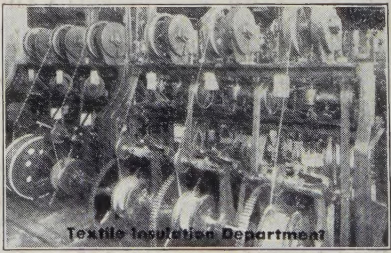


Beldenamel Magnet Wire

Cotenamel Magnet Wire

Silkenamel Magnet Wire

Beldenamel Department



Textile Insulation Department

Belden

Belden Products

Beldenamel and Textile Magnet Wire • Beldenmold Parts • Automotive Wires and Cables • Airplane Assemblies • Radio Wires, Cords and Cables • Rubber Covered Wires • Armored Cables • Flexible Armature Wires • Motor Lead Wires • Braided and Stranded Copper Cables • Cotton Sleeving